THURSDAY, OCTOBER 3, 1889.

PSYCHOLOGY OF PROTOZOA.

The Psychic Life of Micro-organisms: a Study in Comparative Psychology. By Alfred Binet. Translated from the French by Thomas McCormack. (Chicago: The *Open Court* Publishing Company, 1889.)

Psycho-physiologische Protisten-Studien: experimentelle Untersuchungen. Von Dr. Max Verworn. (Jena: Gustav Fischer, 1889.)

THE first of these two works on the psychology of Protozoa is disappointing. Its main object, as indicated in its title, is to investigate the claims which from time to time have been put forward on behalf of unicellular organisms to the possession of consciousness and a certain low order of mental life. Therefore, looking to the position which M. Binet has gained as a successful worker in other departments of psychological inquiry, we were prepared at his hands to meet with a judicious treatment of facts in the light shed by a specially instructed mind. But, far from this, what we do meet with is the special pleading of an advocate who seems to hold a brief on behalf of his little friends, and is determined to force them into a position of intellectual prominence, no matter at what cost of psychological absurdity. Indeed, were it not that the title-page declares the authorship of this work, no one could possibly have supposed that it had been written by a man who had ever opened an elementary text-book on mental science.

In justification of so severe a criticism one or two quotations may be supplied. With regard to suprise and fear he says:—"We may reply upon this point, that there is not a single infusory that cannot be frightened, and that does not manifest its fear by a rapid flight through the liquid of the preparation. If a drop of acetic acid be introduced beneath the cover-glass, in a preparation containing quantities of Infusoria, the latter will at once be seen to flee in all directions like a flock of frightened sheep." His test to prove memory is—"Every time an animal repeats the same action under influence of the same excitations, that fact proves that the animal is possessed of memory." His one criterion of instinct is—"Preadaptation to an end not present, but remote." After such examples, it would be needless to adduce more.[1] In no part of the book is any distinction drawn between activities as reflex or automatic, and conscious or intentional; therefore, if a Protozoon performs any action which is in the smallest degree adaptive, the fact is always taken as in itself sufficient evidence of intelligent volition. Thus, to go no further than the above quotations from his preface, it never seems to have occurred to M. Binet that "rapid flight" in the presence of a stimulating agent may be due to causes other than "fear"; that every excitable tissue (whether *in situ* or excised) which repeats the same action under influence of the same excitation is not forthwith accredited by an experimental physiologist with any psychological "memory"; or that the heart need not necessarily be supposed to beat by "instinct," because each diastole is a "preadaptation" to the next systole.

But not only do we everywhere encounter this astonishing disregard of the most elementary principles of psychology: we are equally surprised at what may be termed a void of general sagacity. For example, in M. Binet's own opinion the strongest evidence he has to adduce in favour of intelligence on the part of "micro-organisms" consists in the behaviour of spermatozoa and spermatozoids towards ova and ovules. Thus, for example, he does not hesitate to say, by way of a general conclusion on this matter, "In fine, the spermatic element, in directing itself toward the ovule to be fecundated, is animated by the same sexual instinct that directs the parent organism towards its female"! In particular, he quotes the interesting researches of Prof. Pfeffer, who found that spermatozoids are strongly attracted by certain solutions (malic acid, &c.), so that they will crowd into a pipette filled with these solutions, even though the latter be strong enough to cause their death. Now, to any ordinary common-sense it must appear that in these facts we have evidence pointing directly away from the hypothesis of intelligent adjustment, and therefore towards the simpler hypothesis of some kind of chemical—or physiological—affinity.

Upon the whole, then, as we have said, M. Binet's work is disappointing; and, we may now add, the disappointment arises not only on account of its astonishing weakness in psychology, but also from its want of full acquaintance with the literature of the subject, and an absence of any original investigations on the part of the author himself.

Of quite a different stamp is the work of Dr. Verworn. Charged throughout with the experimental work of a physiologist, and with the analytical powers of a well-instructed mind, these "Protisten-Studien" are of much value both from a scientific and a philosophical point of view. Like M. Binet, Dr. Verworn has set himself primarily to consider the question as to whether, or how far, the Protozoa ought to be accredited with mental faculties. Therefore a considerable part of his elaborate treatise is devoted to an exposition of those psychological principles, a clear definition of which is so essential to any adequate treatment of this question. The exposition is judicious, and leads to the general conclusion that we have no evidence at all of even the lowest degree of mental life on the part of any of the unicellular organisms. In this connection we may remark that, while M. Binet quotes from an earlier paper Dr. Verworn's observations on the "house-building" habits of *Difflugia urceolata* as one of the most unequivocal examples of Protozoon intelligence, Dr. Verworn himself here furnishes a crushing refutation of this view. For he finds, as a result of experiments with powdered glass, that the *Difflugia* will crawl about among the particles without collecting any, so long as it is left undisturbed; but when irritated by shaking, its pseudopodia retract, and, while doing so, exude sticky little drops, which cause any minute particles over which they happen to pass to adhere and be carried along with the retracting filament, until

[1] Perhaps it is fair to M. Binet to state that these examples are drawn from his preface, which is mainly concerned with an attempt to show that the present writer has not done justice to the mental endowments of the Protozoa. This criticism the present writer has fully answered in the *Open Court*, July 11, 1889.

eventually, upon the total retraction of pseudopod, they are deposited on the substance of the organism. Thus the "house" is built by purely mechanical means, without any "intelligence" or "volition" on the part of *Difflugia*. In the *Contemporary Review* for April 1873, the late Dr. Carpenter alluded to similar habits of a certain marine Protozoa, saying: "The deep-sea researches on which I have recently been engaged have not exercised my mind on any topic so much as on the following." He then describes what he regarded as a selective choice by the Protozoa of *finer* particles of sand by some species, and *coarser* particles by other species, for the purpose of building into the structures of their shells. No doubt, however, if the process were carefully observed, it would be found that this apparently selective choice is really due to the size or quality of the adhesive drops on the pseudopodia, which may very well differ slightly in these respects among the different species.

Much the larger portion of Dr. Verworn's work is, as its title conveys, occupied with an account of his experimental researches. These are thoroughly systematic and fairly exhaustive. First there are thirty pages describing the natural or spontaneous movements characteristic of well-known forms belonging to all the main divisions of the Protozoa. Next there follow a hundred pages dealing with the author's experiments in stimulation, arranged under the headings—luminous, thermal, mechanical, auditory, chemical, and electrical. Lastly, there are over fifty pages describing a number of experiments in various forms of section and artificial division of sundry unicellular organisms. The whole of this part of the research is exceedingly good, and must be studied by everyone who is engaged in practical work. From this point of view the two most interesting facts are, we think, the following. It is a general law of excitable tissues that the principal seat of excitation is the kathode on closing a galvanic circuit, and the anode on opening it. But Dr. Verworn finds that among the Protozoa the reverse of this otherwise general rule obtains. It appears that this curious observation was first made by Kühne as long ago as 1864; but Dr. Verworn has done good service in now calling attention to it, corroborating, and extending it to other unicellular organisms.

The second fact to which we allude is, that when a galvanic current is closed through a drop of water containing a number of Protozoa (*e.g. Paramecium*, *Coleps*, *Colpoda*, *Stentor*, *Halteria*), they will all begin to travel rapidly and directly to the negative pole, and, if the current be left closed for a few seconds, will all become congregated thereat. On now opening the current they will all begin to travel towards the positive pole, but then soon segregate. It was proved that this is not any merely physical phenomenon, but a truly vital one: the Protozoa of the genera named will invariably swim towards the kathode on closing, remain at the kathode so long as the current continues to pass, and swim towards the anode as soon as the current is opened. Even when the kathode is a copper wire, which causes the death of all the Protozoa that approach it, they will equally well congregate in its vicinity, there to perish; and by using a movable kathode of harmless material, the Protozoa may be led about like a flock of sheep following their shepherd. To this curious physiological property on the part of Protozoa, Dr. Verworn has assigned the name "Galvanotropism." But one would like to be informed as to the strength of the current employed, *e.g.* if it were sufficient to induce electrolysis. If the current used was a very weak one, would it not be interesting to try the effect of greatly strengthening it?

The experiments in section were all devoted to testing the value of the nucleus as a co-ordinating centre of movements, ciliary and otherwise. The results were uniformly opposed to the views of Rossbach, Engelmann, and others who have regarded the nucleus in this light—the un-nucleated portions of several Protozoa continuing to exhibit all the same spontaneous movements as the nucleated. It is to be regretted that the author did not more completely extend these researches to an investigation of the functions of the nucleus in respect of nutrition and regeneration, where so much still remains to be done. But we may hope that this is perhaps to follow.

GEORGE J. ROMANES.

OUR BOOK SHELF.

Treatise on Trigonometry. By W. E. Johnson, M.A. (London: Macmillan and Co., 1889.)

WE have here a work which should prove very serviceable to those who are commencing the subject with the hope of proceeding to more advanced mathematics, and also to those wishing to revise their study of trigonometry and to extend it beyond the limits of an ordinary elementary text-book.

The volume is divided into two parts, geometrical and analytical, the former dealing with geometrical applications, the latter with the purely theoretical and analytical side of the subject. The first part deals with the properties of points and circles connected with triangles and rectilinear figures, trigonometrical ratios and their fundamental relations; chapter ix. treats of the geometry of the triangle, including the nine-point circle, the cosine and ex-cosine circles; and in chapter x. we have formulæ for circles and rectilineal figures. In the algebraical part, logarithms, ratios of compound and multiple angles, developments of formulæ for the sums of angles, factorization and summation, are dealt with. In chapter xviii. the proof of the binomial theorem is a modification of Euler's, thereby making it depend directly on the index theorem. Chapter xxi. consists of the application to trigonometrical formulæ of imaginary and complex quantities, and chapter xxii. of a geometrical interpretation of imaginaries.

Short digressions have been made into geometry, algebra, and theory of equations in various parts of the work, thus bringing out more clearly the train of reasoning that is necessary to establish and expound the principles that lie at the foundation of mathematics, to which, in trigonometry, the student is first introduced.

At the end of each chapter is a copious supply of examples, and the book concludes with a set of miscellaneous examples and answers to the above.

LETTERS TO THE EDITOR.

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Taming the Puma.

As I believe that the puma, or Rocky Mountain lion, is usually considered one of the most intractable and untamable of animals, the following brief account of what I have just seen

here, at the close of a brief tour in the Yellowstone National Park, may be of interest:—

Three years ago, Messrs. Wittich Bros., of this city, found some puma cubs in the valley of the Yellowstone River, twenty-five miles from this city. As cubs they showed those spots on the skin to which Mr. Muybridge called our attention at the Royal Society *soirée*, last May, as seen in his photographs of the adult animal, though not in that case visible to the eye. One of these cubs soon died, but the other is now three years old, and is perfectly under the control of Mr. W. F. Wittich, who devoted eighteen months to training her. I saw many proofs of this in his store this evening. The beast not having been fed for twenty-four hours, he trailed pieces of raw meat over her nose and mouth, which the puma never attempted to eat until the word was given, as to a dog. Occasional attempts were made, but a twist of the ear by Mr. Wittich was sufficient to control her. When meat was placed a few yards off, the puma fetched it by word of command, and permitted the meat to be taken from her mouth by Mr. Wittich, who fondled it as he would a cat. A very fine dog, a cross between a pure setter and a pure St. Bernard, five years old, named "Bruce," is on intimate, and even affectionate, terms with the puma, who allowed him to remove meat placed upon her jaws, and to eat it. On one occasion, the puma (who is often allowed to range the house), the dog, and Mr. Wittich, slept together in the same bed, and Mr. Wittich was aroused by the puma attacking some one who roused him in the early morning. When the puma is tied up, the dog always goes to sleep alongside her, and kisses her, the puma responding with a short sharp bark of greeting. The puma follows Mr. Wittich through the streets of this Western city, but has torn to pieces several strange dogs, when unaccompanied by her friend "Bruce." I inclose you a photograph of the dog in the act of removing meat from in front of the puma's jaws; her paws are done justice to, but not the length of her tail. Prior to the exhibition, Mr. Wittich requested the spectators (about ten in number) to remain perfectly still, as the beast (which was loose) noticed, and was angered by, any movement on their part.

Mr. Wittich believes that this is the only puma known to be in captivity, and comparatively tame. In training her he has chiefly used the whip, which she only feels on the nose, ear, and under the tail; he assures me he has made his own teeth meet through her skin in several other parts of her body without her showing any signs of sensation. Her memory is short, and three weeks' intermission of the performance necessitates much extra training and trouble.

I may perhaps add that Mr. W. R. Goodall, an English gentleman who has been living nearly three years ten miles from here on a ranche, assures me that perfect reliance can be placed on Mr. Wittich's statements. What my fellow-travellers and I saw ourselves was sufficiently marvellous, and I am not ashamed to add that we felt somewhat relieved when the animal, which had circulated freely among us, was chained up again! WM. LANT CARPENTER.

Livingston, Montana, U.S.A., August 30.

On some Effects of Lightning.

THE terrific storm which passed over Essex on the night of Monday, the 2nd inst., should give many interesting examples of the effects of lightning. I was at Upminster, 2½ miles from Romford, on the morning following, and had the opportunity of examining a windmill for corn-grinding which had been struck. Perhaps the details may prove of some interest.

The owner, Mr. J. Abraham, and a friend witnessed the flash, which occurred at about 1 a.m., from a window not far from the mill. They describe it as a mass or network of flame, which threw off thousands of sparks like fireworks. After the flash a light appeared on the sail for a few seconds, and they feared the mill would catch fire, but it went out, extinguished, as they suppose, by the heavy rain (I recorded 4·00 inches in seven hours in a field a mile away). I consider it remarkable that the mill was not fired. The splintered wood and cracked boards do not, however, at any attainable point show signs of charring.

The mill is octagonal, and of wood, standing on about 8 feet of brickwork. The joints of the weather boards at the angles are protected by thin sheet lead in strips about 6 × 3 inches, bent over the edge of each board to the next and nailed. At the base of the wooden part is a platform 10 feet wide, and the angle which this makes with the body is also protected with sheet lead. The strips up the angles are connected with this ring round the base, and from the ring again many strips are nailed radially to the edge of the platform. A chain was hanging from top to bottom of the mill, nearly touching the weather boards at the top, and hanging within 2 inches of the boarded ground floor at a distance of about 4 feet from the circumference in the south radius. The upper cap of the mill is revolvable. The sails faced south-east, and were set diagonally.

All the effects of the flash seem to me to indicate that it passed from earth to cloud. One branch of it passed through the iron chain, fusing the links at the points of contact, sufficiently to make them hold together when first disturbed. The flash burst through the weather boarding at the top, breaking the boards away outwards, and then reached one of the iron levers used for opening and closing the shutters of the sails. I was surprised to find no traces of the flash on the boards at the ground. The bottom link of the chain was fused, and there all trace ceased.

A second branch joined the first at the iron lever, coming in the direction described in what follows. Against the north-north-west angle of the platform runs a leaden valley gutter between two outbuildings. The flash seems to have sprung, from some old iron, lying on the ground, to this gutter, and run along it. A small portion went along under the edge of the platform to the west-north-west angle, and then along one of the radial strips. The larger portion entered at once at the north-north-west angle along a radial strip, tearing up the end of it and bending it over on to the platform. On reaching the ring of lead at the base it went round it in both directions, tearing up the lead at every junction, and bending it in the direction of the current. It then ascended by the south-south-east and east-south-east angles only, tearing up each lead strip and curling the end over upwards.

The portion ascending by the south-south-east angle joined that from the inside chain at the place where the boards were burst off. That ascending by the east-south-east angle made a path of its own to the sail lever by perforating a board of the weathering apron which depends from the revolving top of the mill. This perforation, seen from the nearest point I could attain, was evidently from within outwards. The board is cracked from the free edge to the point of perforation, but not badly nor further.

On reaching the ironwork of the sails the whole charge passed along the lever of the north east sail, and on reaching the end of the metal entered the wood. The framework of this was shattered, the shutters smashed and thrown about, bolts broken, and the main shaft splintered. Large pieces were thrown 50 yards and more into an adjoining field.

The charge appears to have left the sail before reaching the extreme end, but as the miller was awaiting the arrival of the Insurance Company's inspector he did not wish to have the sail lowered, and I could not inspect it.

In a few places the lead was partly melted. At some holes where nails were put in, little circles half an inch in diameter were melted cleanly out, and in one place I found the head of a nail partly fused.

I was surprised to find so little damage done to the mill, and think it is a very good illustration of Mr. Tomlinson's remarks in NATURE of August 15 (p. 366), where he suggests that a building to be well protected should have a network of conducting material attached to it. ARTHUR E. BROWN.

31 Vanbrugh Park, Blackheath, September 10.

WITH regard to the two lightning-struck trees near St. Albans, the twisting mentioned by Mr. Pickering is probably not in any way due to the fact that the stroke was dealt by lightning. It is easily accounted for on mechanical principles, even assuming that the toughness of the timber was exactly equal in every part. If the centre of gravity of the dislocated top of the tree lay outside of a certain plane passing through the point of explosion (the position of this plane depending on the tenacity of the stem at that level), such twisting would be inevitable; much as in an earthquake dislocated columns must always be twisted unless the friction of the dislocated surface is equivalent on each side of a certain line running parallel to the direction of motion.

If Mr. Pickering has an opportunity, he might perhaps be able to ascertain whether or no the "core" of each tree is "not exactly in the middle of each stem, but rather to the side

remote from that to which the top has fallen" (see my former letter). If this is the case, it would be strong proof that the explosion actually took place in the core. I shall probably have no opportunity of visiting the spot again for many months.

My recollection is that there are no trees within several feet of the line joining the two damaged ones, which stood in what now looks like an opening in the wood. Mr. Pickering can perhaps check this also. A. F. GRIFFITH.

15 Buckingham Place, Brighton.

IN several letters lately published in NATURE, an explosion in or by a tree trunk is mentioned. Such an explosion occurred here during the great storm of July 12 last. The lightning struck an old crab-tree, at the base of the trunk, and exactly at the ground-line. The crab was growing on the top of a grassy bank. The lightning tore the bank open from top to bottom, tore open and splintered the roots of the crab, and threw pieces of roots and turf, all in one direction, for 21 feet; the turf was in large pieces, of about a foot cube.

A tiled barn near here was, at the same time, struck in a peculiar manner. The lightning struck the upper tiles near a gable; one tile was torn out and hurled away, and several other tiles were neatly perforated with round holes, each about ¼ inch in diameter; the tiles were red, and the holes were burnt grey all round. The wooden pegs belonging to the perforated tiles were blackened by the heat. W. G. S.

Dunstable.

On the Remarkable Form of Hailstones.

WITH reference to the description given in NATURE (vol. xl. pp. 151 and 272) of the hailstorm at Liverpool, it will probably be interesting to bring under notice an early account of the remarkable forms often possessed by hailstones; it is to be found in the *Edinburgh Philosophical Journal* for 1824, vol. xi. p. 326. The writer of the said article states that "in the second part of the eleventh volume of the 'Nova Acta Physico-Medica Academiæ Cæsareæ Leopoldinæ Carolinæ Naturæ Curiosorum,' Dr. Nögerath informs us, that, on May 7, 1822, a tremendous hail-shower fell in and around Bonn. . . . The general size of the hailstones was about one inch and a half in diameter, with a weight of nearly 300 grains. When whole, which was not generally the case, the general outline was elliptical or compressed globular, and the form *cerebral*, or resembling the brain of a warm-blooded animal. . . . More frequently the form was lenticular, and appeared polished on the two ends, as if by friction. The masses had a concentric lamellar structure; in the centre was a white, nearly opaque, nucleus, of a round or elliptical form, around which were arranged concentric layers, which increased in translucency from the innermost to the outermost. They at the same time exhibited a beautiful stellular fibrous arrangement, caused by rows of air-bubbles disposed in radii. . . . Captain Delcross, in the thirteenth volume of the 'Bibliothèque Universelle,' describes hailstones having the concentric lamellar structure and stellular fibrous arrangement. . . . The surface was provided with pyramidal forms. . . . When the edges and the angles of the pyramids are melted down, the *cerebral* form is produced; when the masses of hail, having the structures described, burst asunder, the fragments have a pyramidal form, and then forms what has been described under the name of *pyramidal hail*." The writer then proceeds to describe hailstones which fell on June 27, 1823, at Aberdeen. "They (the hailstones) were included, almost universally, each by five sides or surfaces, four plane, constituting the sides of an irregular pyramid, and one spherical in place of a base. . . . The spherical surface appeared, to the depth of one-twentieth or one-thirtieth of an inch, to be solid as it was transparent. The rest of the hailstone was opaque, consisting of crystals or minute columnar forms, perpendicular to the spherical surface." Eight figures, illustrative of the different kinds of hailstones, are given (Plate ix.).

Miss Holt refers to the metallic taste and the flavour of ozone possessed by those which fell at Liverpool. The presence of NH_3 in hailstones was long ago established by Mène (*Comptes rendus*, May 19, 1851). J. SHEARSON HYLAND.

14 Hume Street, Dublin.

Erinus hispanicus (?) on the Roman Wall.

THE accompanying note on this alien Scrophulariaceous plant will, I think, be of interest to many of your readers, more especially to those who, as members of the British Association, took part in the excursion on Thursday last from Newcastle to the Roman Wall.

The plant occurs on some Roman remains at Chesters, Chollerford, Northumberland, the residence of Mr. John Clayton. In the recent editions of Dr. Bruce's "Hand-book to the Roman Wall," it is named *Erinus hispanicus*, but it appears to have been previously known as *E. alpinus*. In endeavouring to determine its authoritative name, I have ascertained that the plant was called *E. hispanicus* by Persoon ("Synopsis"), who regarded it as a doubtful species, whereas all other authors regard it as a variety of *E. alpinus*. There is a specimen, apparently of this plant, in the Oxford Herbarium, collected by Endress ("Plantæ Pyrenaicæ exsiccatæ, Annis 1829-30 lectæ") which he calls *E. alpinus*, var. *lanuginosus*; Grenier and Godron ("Flore Française") call it *E. alpinus*, var. *hirsutus*; Lange calls it *E. alpinus*, var. *villosus*; and Willkomm and Lange, in their "Flora Hispanica," follow Grenier and Godron, giving the other names as synonyms. It will doubtless be best to accept Willkomm and Lange's conclusion, and adopt the name *E. alpinus*, var. *hirsutus*, Grenier et Godron.

I may add that *E. alpinus*, L., is mentioned, in Babington's "Manual of British Botany," as occurring near Tanfield, in Yorkshire, a locality which is also given in the last edition of Hayward's "Botanist's Pocket-Book." However, in Arnold Lees's "Flora of West Yorkshire" (1888), it is stated that this plant has disappeared from Tanfield. Consequently Chesters is now the only English locality for *Erinus*, and the only form is the var. *hirsutus*. SYDNEY H. VINES.

Oxford, September 23.

Noctilucous Clouds.

THE recent communications in NATURE in relation to apparently self-luminous cloud-like bands in the skies after nightfall, call to mind the analogous phenomena of noctilucous clouds involving the whole visible firmament.

We are indebted to the indefatigable industry and zeal of the illustrious Arago for the collection of the scattered facts relating to the phenomena of self-luminous clouds of divers kinds.[1] According to the records collected by him, noctilucous bands and zones of clouds are sometimes associated with the electrical manifestations accompanying distant thunderstorms. To this class belong the luminous phenomena noticed by Rozier on August 15, 1781, and by Nicholson on July 30, 1797. In other cases, the association of the phenomena with electrical disturbances, is by no means obvious. To this class belong the luminous clouds observed by Beccaria over his observatory at Turin; likewise the luminous appearances witnessed by Deluc near London, and also those observed by Major Sabine over the Isle of Skye in Scotland. In all these cases, the noctilucous condition of the clouds was localized and confined to bands or zones in limited portions of the sky. But under certain conditions this apparently self-luminous property of the nocturnal clouds involves the entire visible hemisphere. It is to this latter aspect of the noctilucous phenomena that I desire to call attention.

Omitting the consideration of the exceptionally rare and anomalous phenomena of so-called phosphorescent "dry-fogs," as those of 1783 and 1831, in which the luminosity was so pronounced as to enable one to read ordinary print at midnight, we come at once to the generally recognized phenomenon of that faint diffused cloud-luminosity which enables the "country doctor," with comparative security, to perform his lonely midnight drives on cloudy moonless nights. Frequently the glow is so faint that it is only possible to observe it at a distance from cities and large towns, in places where the air is free from smoke, and where the darkness of the sky is not affected by the general illumination due to gas and electric lights.

The conditions under which the phenomena most conspicuously manifested themselves to my observations were during the incipient stages of the autumnal north-east storms occurring

[1] *Annuaire du Bureau des Longitudes pour l'An* 1832, pp. 246-50; *ibid.*, 1838, pp. 279-85. "Œuvres Complètes de Arago," vol. iv. pp. 70-77. Arago's "Meteorological Essays," translated by Sabine, pp. 48-53 (London, 1855).

near the sea-coast of Georgia (U.S.A.). In these three-days cyclonic storms, before the rain begins and usually before the lowest strata of air are sensibly disturbed by the upper currents, the low-lying dense masses of clouds coming from the north-east scud across the skies with great rapidity. Under these circumstances, during moonless nights, the general illumination is sufficient to plainly indicate the road to the traveller, even when it is bordered by tall overhanging trees. Under ordinary circumstances, an equivalent degree of cloudiness would have compelled the traveller to abandon all attempts at guiding the horse, and to rely entirely upon the superior acuteness of the nocturnal vision of his equine companion. In such storms, the cloudiness involves the entire firmament, and there are no electrical manifestations. To the traveller, the general illumination apparently surpasses that of a starlight cloudless night.

Now the question is, What is the origin and source of this general nocturnal illumination on cloudy moonless nights? No degree of cloudiness seems to completely obliterate the faint illumination. For, as Arago intimates, even when the heavens are overcast, during moonless nights, and the stars are hidden by an unbroken mass of the most dense clouds, there is a sufficiency of diffused light in the open country to prevent the difficulty and inconvenience which would attend any attempt to walk in the Cimmerian darkness of a cavern.

It is a popular opinion that the clouds act like ground-glass lamp-shades in diffusing the aggregate starlight, so as to produce a faint illumination from all parts of the sky, and thus obliterating shadows on the surface of the earth due to the greater amount of light radiated from the more luminous regions of the celestial vault. But Arago justly maintains that when we consider the immense effect of clouds in weakening the dazzling light of the sun on particular days in winter, it is scarcely possible to admit that the faint diffused light, which, on a cloudy night, guides the steps of the traveller, comes from the stars. In other terms, in view of the loss from reflection and absorption, the amount of starlight penetrating the cloud-canopy seems to be quite inadequate to account for the degree of general illumination observed at the surface of the earth. If we exclude the stellar origin, there remains no other explanation of the nocturnal light of a clouded sky, except the admission that the clouds themselves have a luminosity of their own. This is the view taken by Arago.

But since, for all degrees of obscuration, more or less of the starlight incident upon the canopy of clouds must penetrate it, and be diffused at the surface of the earth, this source of luminosity must be looked upon as a *vera causa*. Its adequacy to explain the observed illumination in any given case will depend upon the density of the overcasting cloudy masses and upon the sensitiveness of the human organ of vision. Hence it seems to be more rational to conclude that some portion of the nocturnal luminosity of clouds may be due to the faint diffused starlight; but that, when the amount of illumination from comparatively dense noctilucous clouds surpasses that of clear moonless nights, we are warranted in assigning them self-luminous properties. This seems to have been the condition of the low, dense, and rapidly-drifting clouds observed by me during the incipient stages of north-east storms on the Atlantic coast. Moreover, the fact that an equal degree of cloudiness is not always attended with an equal amount of illumination points to the same conclusion. In other words, it seems to be reasonable that the degree of luminosity sometimes manifested in the deep winter nights, when the whole heavens are overcast with dense clouds, is vastly too great to be due to diffused stellar light, and is more probably ascribable to the greater or less self-luminous properties of the clouds themselves.

In the case of isolated clouds, augmented nocturnal brightness may be due to well-known local causes, independent of self-luminosity. For example, the source of the brightness of the clouds observed by Prof. Piazzi Smyth in 1882 and 1883, was traced by him to the reflection of the gas-lights of the city of Edinburgh, from water-drops in the clouds (NATURE, vol. xxviii. p. 239). In like manner, the bright nocturnal clouds observed by Mr. T. W. Backhouse and others in 1886 (NATURE, vol. xxxiv. pp. 239, 312, 386) were probably due to bands of lofty clouds illuminated by the lingering sunlight.

But even in cases in which the noctilucous condition of the clouds is general, it is more than possible that the starlight illumination may be reinforced by the prolonged twilights due to the reflection of sunlight from attenuated solid particles suspended in the supra-cirrus strata of the atmosphere, such as were manifested after the Krakatão eruption in the autumn of 1883. Moreover, in certain cases the stellar illumination may be strongly augmented by cloud-obscured auroral lights. These several possible sources of extra-stellar illumination of the sky during cloudy nights seem almost to preclude the necessity of the assumption of the existence of the condition of self-luminosity of clouds under any circumstances.

But, admitting the occasional self-luminous condition of clouds, the question is, What are the physical causes of their luminosity? It is customary to refer such obscure luminous phenomena to phosphorescence or to electricity. But it must be confessed that, in the absence of definite knowledge of the physical causes of the phosphorescence of clouds, on the one hand, or of distinct electrical manifestations in such clouds, on the other, such explanations, so far from enlightening us, would seem to be more akin to illustrating the obvious by the obscure.

Seafaring men must have had numerous opportunities of observing nocti ucous clouds in various latitudes under every degree of obscuration; but I do not, at present, recollect any reference to such observations on the ocean. In "The Voyage of H.M.S. *Challenger*," in the "Memorandum of Meteorological Observations," under head "Weather," there is a record of the "visibility of distant objects"; but I have been unable to find any night-observations of visibility ("Narrative," vol. ii. p. 300 *et seq.*).

Berkeley, California, August 30. JOHN LE CONTE.

ON BOSCOVICH'S THEORY.[1]

WITHOUT accepting Boscovich's fundamental doctrine that the ultimate atoms of matter are points endowed each with inertia and with mutual attractions or repulsions dependent on mutual distances, and that all the properties of matter are due to equilibrium of these forces, and to motions, or changes of motion produced by them when they are not balanced; we can learn something towards an understanding of the real molecular structure of matter, and of some of its thermodynamic properties, by consideration of the statical and kinetic problems which it suggests. Hooke's exhibition of the forms of crystals by piles of globes, Naviers's and Poisson's theory of the elasticity of solids, Maxwell's and Clausius's work in the kinetic theory of gases, and Tait's more recent work on the same subject—all developments of Boscovich's theory pure and simple—amply justify this statement.

Boscovich made it an essential in his theory that at the smallest distances there is repulsion, and at greater distances attraction; ending with infinite repulsion at infinitely small distance, and with attraction according to Newtonian law for all distances for which this law has been proved. He suggested numerous transitions from attraction to repulsion, which he illustrated graphically by a curve—the celebrated Boscovich curve—to explain cohesion, mutual pressure between bodies in contact, chemical affinity, and all possible properties of matter—except heat, which he regarded as a sulphureous essence or virtue. It seems now wonderful that, after so clearly stating his fundamental postulate which included inertia, he did not see inter-molecular motion as a necessary consequence of it, and so discover the kinetic theory of heat for solids, liquids, and gases; and that he only *used* his inertia of the atoms to explain the known phenomena of the inertia of palpable masses, or assemblages of very large numbers of atoms.

It is also wonderful how much towards explaining the crystallography and elasticity of solids, and the thermo-elastic properties of solids, liquids, and gases, we find without assuming more than one transition from attraction to repulsion. Suppose, for instance, the mutual force between two atoms to be repulsive when the distance between them is $< Z$; zero when it is $= Z$; and attractive when it is $> Z$: and consider the equilibrium of groups of atoms under these conditions.

[1] Abstract by the Author of a communication to Section A of the British Association, on Friday, September 13, at Newcastle.

A group of two would be in equilibrium at distance Z; and only at this distance. This equilibrium is stable.

A group of three would be in stable equilibrium at the corners of an equilateral triangle, of sides Z; and only in this configuration. There is no other configuration of equilibrium except with the three in one line. There is one, and there may be more than one, configuration of unstable equilibrium, of the three atoms in one line.

The only configuration of stable equilibrium of four atoms is at the corners of an equilateral tetrahedron of edges Z. There is one, and there may be more than one, configuration of unstable equilibrium of each of the following descriptions:—

(1) Three atoms at the corners of an equilateral triangle, and one at its centre.

(2) The four atoms at the corners of a square.

(3) The four atoms in one line.

There is no other configuration of equilibrium of four atoms, subject to the conditions stated above as to mutual force.

In the verbal communication to Section A, inportant questions as to the equilibrium of groups of five, six, or greater finite numbers, of atoms were suggested. They are considered in a communication by the author to the Royal Society of Edinburgh, of July 15, to be published in the Proceedings before the end of the year. The Boscovichian foundation for the elasticity of solids with no inter-molecular vibrations was slightly sketched, in the communication to Section A, as follows.

Every infinite homogeneous assemblage[1] of Boscovich atoms is in equilibrium. So, therefore, is every finite homogeneous assemblage, provided that extraneous forces be applied to all within influential distance of the frontier, equal to the forces which a homogeneous continuation of the assemblage through influential distance beyond the frontier, would exert on them. The investigation of these extraneous forces for any given homogeneous assemblage of single atoms—or of groups of atoms as explained below—constitutes the Boscovich equilibrium-theory of elastic solids.

To investigate the equilibrium of a homogeneous assemblage of two or more atoms, imagine, in a homogeneous assemblage of groups of i atoms, all the atoms except one held fixed. This one experiences zero resultant force from all the points corresponding to it in the whole assemblage, since it and they constitute a homogeneous assemblage of single points. Hence it experiences zero resultant force also from all the other $i - 1$ assemblages of single points. This condition, fulfilled for each one of the atoms of the compound molecule, clearly suffices for the equilibrium of the assemblage, whether the constituent atoms of the compound molecule are similar or dissimilar.

When all the atoms are similar—that is to say, when the mutual force is the same for the same distance between every pair—it might be supposed that a homogeneous assemblage, to be in equilibrium, must be of single points; but this is not true, as we see synthetically, without reference to the question of stability, by the following examples, of homogeneous assemblages of symmetrical groups of points, with the condition of equilibrium for each when the mutual forces act.

Preliminary.—Consider an equilateral[2] homogeneous assemblage of single points, O, O′, &c. Bisect every line between nearest neighbours by a plane perpendicular to it. These planes divide space into rhombic dodekahedrons. Let A_1OA_5, A_2OA_6, A_3OA_7, A_4OA_8, be the diagonals through the eight trihedral angles of the dodekahedron inclosing O, and let $2a$ be the length of each. Place atoms Q_1, Q_5, Q_2, Q_6, Q_3, Q_7, Q_4, Q_8, on these lines, at equal distances, r, from O; and do likewise for every other point, O′, O″, &c., of the infinite homogeneous assemblage. We thus have, around each point A, four atoms, Q, Q′, Q″, Q‴, contributed by the four dodekahedrons of which trihedral angles are contiguous in A, and fill the space around A. The distance of each of these atoms from A is $a - r$.

Suppose, now, r to be very small. Mutual repulsions of the atoms of the groups of eight around the points O will preponderate. But suppose $a - r$ to be very small: mutual repulsions of the atoms of the groups of four around the points A will preponderate. Hence for some value of r between O and a, there will be equilibrium. There may, according to the law of force, be more than one value of r between O and a giving equilibrium; but whatever be the law of force, there is one value of r giving *stable* equilibrium, supposing the atoms to be constrained to the lines OA, and the distances r to be constrainedly equal. It is clear from the symmetries around O and around A, that neither of these constraints is necessary for mere equilibrium; but without them the equilibrium might be unstable. Thus we have found a homogeneous equilateral distribution of 8-atom groups, in equilibrium. Similarly, by placing atoms on the three diagonals, B_1OB_5, B_2OB_5, B_3OB_6, through the six tetrahedral angles of the dodekahedron around O, we find a homogeneous equilateral distribution of 6-atom groups, in equilibrium.

Place, now, an atom at each point O. The equilibrium will be disturbed in each case, but there will be equilibrium with a different value of r (still between o and a). Thus we have 9-atom groups and 7-atom groups.

Thus, in all, we have found homogeneous distributions of 6-atom, of 7-atom, of 8-atom, and of 9-atom groups, each in equilibrium. Without stopping to look for more complex groups, or for 5-atom or 4-atom groups, we find a homogeneous distribution of 3 atom groups in equilibrium by placing an atom at every point O, and at each of the eight points A_1, A_5, A_2, A_6, A_3, A_7, A_4, A_8. This we see by observing that each of these eight A's is common to four tetrahedrons of A's, and is in the centre of a tetrahedron of O's; because it is a common trihedral corner point of four contiguous dodekahedrons.

Lastly, choosing A_2, A_3, A_4, so that the angles A_1OA_2, A_1OA_3, A_1OA_4 are each obtuse,[1] we make a homogeneous assemblage of 2-atom groups in equilibrium by placing atoms at O, A_1, A_2, A_3, A_4. There are four obvious ways of seeing this as an assemblage of di-atomic groups, one of which is as follows:—Choose A_1 and O as one pair. Through A_2, A_3, A_4 draw lines same-wards parallel to A_1O, and each equal to A_1O. Their ends lie at the centres of neighbouring dodekahedrons, which pair with A_2, A_3, A_4 respectively.

For the Boscovich theory of the elasticity of solids, the consideration of this homogeneous assemblage of double atoms is very important. Remark that every O is at the centre of an equilateral tetrahedron of four A's; and every A is at the centre of an equal and similar, and same-ways oriented, tetrahedron of O's. The corners of each of these tetrahedrons are respectively A and three of its twelve nearest A neighbours; and O and three of its twelve nearest O neighbours. By aid of an illustrative model showing four of the one set of tetrahedrons with their corner atoms painted blue, and one tetrahedron of atoms in their centres, painted red, the mathematical theory which the author had communicated to the Royal Society of Edinburgh, was illustrated to Section A.

In this theory it is shown that in an elastic solid constituted by a single homogeneous assemblage of Boscovich atoms, there are in general two different rigidities, n, n_1, and

[1] "*Homogeneous assemblage of points*, or *of groups of points*, or *of bodies*, or *of systems of bodies*," is an expression which needs no definition, because it speaks for itself unambiguously. The geometrical subject of homogeneous assemblages is treated with perfect simplicity and generality by Bravais, in the *Journal de l'Ecole Polytechnique*, cahier xix. pp. 1–128 (Paris, 1850).

[2] This means such an assemblage as that of the centres of equal globes piled homogeneously, as in the ordinary triangular-based, or square-based, or oblong-rectangle-based, pyramids of round shot or of billiard balls.

[1] This also makes A_2OA_3, A_2OA_4, and A_3OA_4 each obtuse. Each of these six obtuse angles is equal to $180 - \cos^{-1}(1/3)$

one bulk-modulus, k; between which there is essentially the relation

$$3k = 3n + 2n_1,$$

whatever be the law of force. The law of force may be so adjusted as to make $n_1 = n$; and in this case we have $3k = 5n$, which is Poisson's relation. But no such relation is obligatory when the elastic solid consists of a homogeneous assemblage of double, or triple, or multiple Boscovich atoms. On the contrary, any arbitrarily chosen values may be given to the bulk-modulus and to the rigidity, by proper adjustment of the law of force, even though we take nothing more complex than the homogeneous assemblage of double Boscovich atoms above described.

The most interesting and important part of the subject, the kinetic, was, for want of time, but slightly touched in the communication to Section A. The author hopes to enter on it more fully in a future communication to the Royal Society of Edinburgh. WILLIAM THOMSON.

NOTES.

THE model of a memorial to Prjevalsky, which is to be erected on the shore of Lake Issyk-kul, is being exhibited at St. Petersburg. It represents a rock, upon which an eagle is descending, having a map of Asia in its talons, and an olive branch in its beak. The monument will have the inscription: "To the first explorer of Nature in Central Asia."

THE Durban Correspondent of the *Times* telegraphs that the Cape Government has decided to adopt Prof. Seeley's proposal for a geological survey under his charge. He believes that other eruptive diamond-bearing tracts like Kimberley exist elsewhere.

IT is understood that a sum of £2000 has been presented to the University of St. Andrews for the purpose of erecting buildings and equipping a chemical laboratory in connection with the Chemical Chair in the United College of St. Andrews.

THE late Alderman George, of Leeds, has bequeathed £10,000 to the Yorkshire College.

THE Harveian Oration will be delivered at the Royal College of Physicians by Dr. James E. Pollock, at 4 o'clock precisely, on Friday, October 18.

THE Queen has been pleased, on the recommendation of the Secretary for Scotland, to appoint Mr. R. Fitzroy Bell, advocate, to be Secretary to the Scottish University Commissioners, constituted under the Universities (Scotland) Act of last session.

ON Monday the International Congress of the Ethnographic Sciences was opened in Paris, at the Trocadéro, under the presidency of M. Jules Oppert, Member of the Institute and Professor at the College of France. In opening the proceedings M. Oppert defined the province of ethnography, and enumerated six sections into which the Committee of the Congress had divided the ethnographic sciences. These were: (1) general ethnology; (2) ethics and sociology; (3) ethnographic pyschology; (4) comparative religion, with a sub-section devoted to Buddhism; (5) philology; and (6) archæology and the fine arts.

THE Congress on Hydrology and Climatology meets in Paris to-day. After the meeting there will be an excursion to the Vosges.

AT the Colonial Exhibition in Paris, visitors may now obtain pamphlets, issued by the French Government, concerning the different colonies, their resources, and the advantages they offer to immigrants. Those relating to the Victoria and the New Zealand exhibits are very good.

AT St. Petersburg, on September 7, several Pulkova astronomers and geodesists took advantage of the ascent of a balloon, belonging to the Technical Society, to test the accuracy of barometrical measurements. The aëronauts, who reached a height of 1800 metres, took with them, besides chronometers and various meteorological instruments, a barometer, a barograph, and an aneroid; and they obtained, in addition to the curve of the barograph, the various heights at which the balloon stood during its ascent and descent for twenty-eight different moments. The heights obtained from these measurements will be compared with those found by geodetical angular measurements, which were made at five different places as far distant from one another as Cronstadt, the St. Petersburg University, Kolpino, and Pargolovo; that is, at distances of more than thirty miles between the extreme stations. The geodetical measurements thus secured are now being calculated.

THE Brussels Correspondent of the *Times* points out that the number of foreign students at the German Technical High Schools is steadily increasing, especially at Berlin, where, last year, there were thirteen English students preparing for the professions of mechanical and mining engineers, architects, and chemists.

WE regret to announce the death, at Manila, on July 28 last, of Senor Don Sebastian Vidal, Inspector-General of the Philippine Island Forests and Director of the Manila Botanic Garden. He held the post for a considerable period, and was the author of numerous important works on Philippine botany. He paid two visits to this country in his official capacity; a first of two months' duration, in the autumn of 1877, and a second of four months', in 1883-84. Both periods were spent at Kew in working up the Philippine flora; and he deposited in the Herbarium a set of no less than 4062 specimens for future reference. His published works are:—"Catalogo metódico de la Plantas Leñosas observadas en la Provincio de Manila," 1880; "Rèsena de la Flora del Archipiélago Filipino," 1883; "Sinopsis de Familias y Generos de Plantas Leñosas de Filipinas," 1883, with an atlas of 100 folio lithographed plates; "Phanerogamæ Cumingianæ Philippinarum," 1885; and "Revision de Plantas Vasculares Filipinas," 1886. The two latter were the result of his last visit to Kew, and he was assisted in their preparation by Mr. R. A. Rolfe of that establishment. Senor Vidal was the first to investigate the Philippine flora since the time of Blanco (when geographical botany as a science was practically non-existent), and we owe to him, not merely a widely extended knowledge of its constitution, but also the establishment of the fact that the Philippine flora, though substantially Malayan in character, yet presents a number of very important peculiarities. We cannot but announce the death of so energetic and promising a worker with profound regret, and hope that his successor will carry on the work with the same amount of success.

AN Indian native paper announces that the Newab of Junagadh has communicated with the Meteorological Department of the Government of India offering to start an observatory at Verawal, and to make suitable arrangements for the exhibition of storm signals for apprising the shipping of the port of the advent of storms in the Arabian Sea. The Dewan of His Highness has offered a building for housing the meteorological instruments, and proposes to erect a shed for the reception of the thermometers on a site near the seashore of Verawal, and to assist generally the Meteorological Department to start an observatory.

MR. HOWARD CUNNINGHAM, the Honorary Curator of the Wiltshire Museum, writes complaining that the monoliths of Stonehenge are being defaced by the names and initials of visitors, and that the inclosure has become "like a pigsty," owing to the litter of broken bottles and other relics of the British holiday-maker. The state of one of the most ancient and interesting of

our monuments is said to be far worse than it was fifteen years ago, and there is nobody at present to look after it.

ACCORDING to Mr. W. C. Wilkinson, of New York, there is a lamentable decay of what he calls "the reading habit" of the American community. He has addressed to the *Nation* a letter in which he says that if the census taken could next year require people everywhere to name the books they had read during the previous twelve months, the result would probably show that not one person in a hundred in the United States had been the reader of even a single book. Some time ago Mr. Wilkinson took a leisurely drive from the Hudson to the Genesee, "through one of the most enlightened and most thriving belts of country in the Empire State of the Union," and during the journey he tried in various ways to find out from a considerable number of people the nature and extent of their recent familiarity with books. "I found the fact superfluously made out," he says, "that, so far at least as rural regions may be taken to represent in this respect the country at large, not many persons in comparison to the whole number of our population are book-readers."

THE *Century Magazine* for October contains some interesting reminiscences of Sir John Herschel by the late Miss Maria Mitchell, who, during her visit to England in 1857, was for some time his guest. "I could scarcely believe," she says, "when I saw Sir John Herschel in his family, guessing conundrums with the children, playing at spelling, and telling funny anecdotes, that he was the same man of whom one had said to me when I first landed in England, 'He is living at Hawkhurst, not very well, and not very good-natured.' Probably the expression on his countenance of physical suffering had been mistaken for ill temper. He was remarkably a gentleman; more like a woman in his instinctive perception of the wants and wishes of a guest." Sir John told "pleasant little anecdotes of some self-made astronomers who came to him with most absurd notions, such as the non-existence of the moon—founded upon the reading of his works! And one good soul sent to him to have a horoscope cast, and inclosed a half-crown. Another wrote to him asking, 'Shall I marry, and have I seen her?'"

AN ethnographical work on the Caroline Islands, by J. S. Kubary, is about to be published, in three parts, at Leyden. The full title is "Ethnographische Beiträge zur Kenntnis des Karolinen Archipels." The work is said to present the results of much observation and study, and it will contain many illustrations prepared from the author's original sketches.

IN the new number of the *Internationales Archiv für Ethnographie* (Band ii. Heft. iv.), Dr. Luschan concludes his valuable and interesting paper on the Turkish "Schattenspiel," and Dr. O. Schellong gives a graphic account of the so-called Barlum Festival in Kaiser Wilhelm's Land. Dr. Schellong's paper is an important contribution to our knowledge of the customs of the Melanesians.

ACCORDING to the scheme adopted by the Italian Royal Commission to commemorate the work of Columbus, a "Raccolta Colombiana" will be published, in six volumes, devoted to (1) the writings of Columbus; (2) Columbus and his family; (3) the discovery of America: (4) navigation and cartography of the discovery; (5) monographs (Italian precursors and continuers of the work of Columbus); (6) bibliography. This work will apparently be the outcome of a large amount of diligent research.

THE Congress on Education, organized under the patronage of, and with a subvention from, the Paris Municipal Council, has concluded its sittings. It was attended principally by teachers, and there were nearly as many women as men. A considerable number of Russian and Polish teachers were present, together with a few delegates from Belgium, England, Italy, and Switzerland. The tone of the debates soon rendered it evident (the *Times* Correspondent says) that by free education the Congress meant freedom from clerical and official control. The general spirit animating the Congress was well expressed by the resolutions carried. The first was to the following effect:—"That public education should have for its object the perfecting of society by the integral culture of man; it should have a scientific character, and should employ the experimental and deductive methods of observation; it should aim at preparing mankind, from a moral, social, industrial, and agricultural point of view, for a better future, and a state of society where inequality and injustice, privileges and the exploitation of man by man, ignorance and superstition, will tend more and more to disappear. By integral education it is meant that all forms of instruction shall be equally accessible to all pupils, whether rich or poor." The Swiss delegate explained that in several cantons the pupils had free meals as well as free education. In the governing of educational matters the Congress thought there was danger in allowing any one particular class of interests to predominate. Parents especially were looked upon with suspicion as being too often opposed to progress, which was more likely to be initiated by the school teachers, the municipalities, or the State. The Congress voted that these four elements should together decide educational matters. It also pronounced itself in favour of mixed schools, where boys and girls should work side by side at the same lessons, and be sometimes taught by men and sometimes by women. A great deal of evidence was given to show that this developed the spirit of emulation and produced a higher tone of morality than the separate system. Mme. Héliga Löwy gave a pathetic account of the tyranny prevailing in Russian Poland, where boys were flogged and expelled from school if overheard speaking their native language, and explained the measures taken by the Russian Government to prevent the growth of education, quoting an official decree stating that knowledge spread too rapidly among the people, and that this menaced social order.

AT the Sanitary Conference at Worcester last week a very interesting paper on sewage and fish was read by Mr. Willis Bund, a well-known barrister and authority on inland fishery matters, and Chairman of the Severn Fishery Board. His suggestion was that the standard of purity for effluents from sewage works should be that the effluent should be purified to such an extent that no effect would be produced upon fish that frequented the stream into which the effluent flowed. Incidentally Mr. Willis Bund gave much interesting information on fish and sewage in this country. Dividing the rivers of the country into those in which *Salmonidæ* are found and those where they are not, he said that curiously enough, up to the present time, with one exception (York), all sewage works had been placed on rivers from which *Salmonidæ* were absent. It had for a long time been the fashion to say that the effluent from sewers did not injure fish life, because fish were often seen feeding at the sewers' mouths, but fresh sewage was limited, and the class of fish usually found near sewers and drains were known as coarse or white fish—roach, dace, chub, &c.; but it was a fact that the *Salmonidæ* did not feed at the entrance to sewers, and were not found there. Speaking broadly, he said the fish that inhabit the English rivers are divided into two great classes—*Cyprinidæ*, or fish of the carp family, and *Salmonidæ*, or fish of the salmon family. The first are resident in fresh water; the latter comprise migratory species. The first are far more tenacious of life than the second, and will live and even thrive under circumstances in which the second would die at once. Curiously enough, sewage experiments have been made almost exclusively on members of the *Cyprinidæ*, and usually on fish that are the hardiest and most difficult to kill of that family; and yet more curiously, the fish usually selected for experiment is a fish not

indigenous to British waters, but one of the hardiest of all the *Cyprinidæ*—the gold-fish. It is difficult to say what amount of impurity a gold-fish will not live in. Yet it is on this fish that the experiments of the effect of sewage and impure effluents are usually made, probably because the gold-fish can be bought more cheaply and more easily than almost any other live fish. Hitherto the rivers on which sewage works had been erected had either had no fish at all in them or had had the hardiest member of the *Cyprinidæ*. He thought that those who were interested in river pollution would be doing useful work by preparing a classified list of the rivers of England and Wales, thus—(*a*) rivers not containing fish; (*b*) rivers containing *Cyprinidæ* only; (*c*) rivers containing *Cyprinidæ* and non-migratory *Salmonidæ*; (*d*) rivers containing migratory *Salmonidæ*. For each class a minimum standard of purity should be agreed to.

THE Ceylon papers announce the death of an elephant named Sella, which had served the Public Works Department for over sixty-five years. Originally Sella belonged to the last of the Kings of Kandy, Sri Wickrema Raja Singha, and was one of about 100 elephants which passed to the British Government in 1815, when the Kandyan dynasty was overthrown and the whole island passed under British rule. It was supposed at that time that Sella was fifteen years of age, but this was uncertain. In 1880 it was decided that all the elephants belonging to the Public Works Department should be sold, and Sella fell to a well-known resident of Colombo, Mr. de Soysa. The animal aided in several *keddah* operations for the capture and taming of wild elephants, but became totally blind about three years ago. He continued, however, to work at the plough until within a short time of his death. After death the tusks were removed, and measured 5 feet in length. Sella himself was 8 feet high.

THE autumn gathering organized by the promoters of the University Extension Scheme in Edinburgh began on the 24th ult., and it will go on till October 5. The objects of the gathering are officially stated to be to make known the advantages of the University Extension Scheme, to afford to those who have not received a University education some experience of University life and practice, and to consider the propriety of organizing "reading centres" in Scotland in connection with the National Home Reading Union. The promoters have been fortunate in securing the assistance of some of the most eminent literary men and men of science in Edinburgh, including Profs. Masson, Tait, Crum Brown, Cossar Ewart, and Geikie; while the syllabus offers a very attractive programme in the five departments of physical science, biological science, political science, history and ethics, literature and art and music. There are forty-five lecturers in all, and the lectures, numbering upwards of fifty, will be delivered on nine days. The opening lectures on the 24th, by Profs. Kirkpatrick and Crum Brown, were attended by about 100 persons, and Prof. Tait at his lecture on Wednesday had an audience of some 200, and on all these occasions the larger proportion were ladies.

THE twelfth annual meeting of the Midland Union of Natural History Societies was held in Oxford on the 23rd and 24th ult. The visitors, who were rather numerous, met the Oxford Society at the University Museum in the Parks at half-past one o'clock on Monday. The company was divided into small parties, who were conducted to the various places of interest. The annual meeting followed, under the presidency of Mr. E. B. Poulton, F.R.S., who subsequently delivered the Presidential address, taking for his subject "Heredity." In the evening a *conversazione* was held, at which about four hundred persons were present, including all the leading members of the University now in Oxford. The large lecture-room of the Sheldonian Theatre was crowded with an audience to hear Dr. Tylor's description of the savage methods of obtaining fire. Sir Henry Acland afterwards made a brief speech, pointing out the great progress which science had made in Oxford. Many objects of interest were also exhibited, including some specimens of sand grouse, and specimens of the whole of the grasses of Oxfordshire. Mr. H. Balfour explained the principal objects in the Pitt-Rivers anthropological collection in the Museum, and Mr. Poulton described the local specimens of geology. The afternoon of the second day was spent at the Radcliffe Observatory.

PROF. GIGLIOLI was the delegate for Italy to the Ornithological Congress held at Vienna, in 1884, under the presidency of the late Crown Prince Rudolph of Austria—a Congress at which, the *Times* report stated, "England was conspicuous by its absence." The subjects which the programme of this Congress set forth were of so trivial a nature that it is scarcely to be wondered at that English ornithologists, who seem to fight shy of Congresses as a rule, scarcely deemed it worth while to journey to Vienna to discuss such problems as the origin of the common fowl, &c. Nevertheless, the results of that Congress were really of great importance. Not only were several first-class memoirs presented to the meetings, but the institution of an International Committee for the purpose of creating stations of observation on the distribution and migrations of European birds was a distinct step in advance, and had no more important work than that of Prof. Giglioli resulted from this determination, it would alone have justified the meeting of the Congress. As a matter of fact, however, these *réunions* of zoologists, such as the one that has just taken place in Paris, are the means of bringing together men who might not otherwise meet; and as a vehicle for the interchange of ideas, and of forming acquaintances which result in the permanent benefit of the institutions to which the Congressmen belong, they are to be greatly encouraged. Prof. Giglioli was appointed, on his return, official ornithologist for Italy by the Minister of Agriculture, Industry, and Commerce, and he at once enlisted a valuable corps of coadjutors in different parts of the Italian peninsula, and the records of these observers are now presented to us in a substantial volume which is entitled "Primo resoconto dei risultati della inchiesta ornitologica in Italia." A map of Italy, which accompanies the volume, marks the places where observations have been made—about 200 in number, with nearly 300 observers. Taking, therefore, his own "Avifauna Italica" as a groundwork, Prof. Giglioli follows the same order in making his record of observations, so that anyone studying the birds of Italy can find out exactly what has been done in the way of discovery since the appearance of the above-mentioned work—an admirable advantage to the student of geographical distribution.

THE University College of North Wales has issued its Calendar for the year 1889–90.

THE additions to the Zoological Society's Gardens during the past week include a Red-handed Tamarin (*Midas rufimanus*) from Surinam, presented by Miss Gladys E. Meyrick; two Black-footed Penguins (*Spheniscus demersus*) from South Africa, presented by Mr. Harding Cox, F.Z.S.; a Peregrine Falcon (*Falco peregrinus*) captured in the Red Sea, presented by Mr. T. J. Taylor; a Common Pintail (*Dafila acuta*), European, presented by Mr. R. Terrot; a Himalayan Bear (*Ursus tibetanus*, ♂) from Northern India, two Common Cassowaries (*Casuarius galeatus*) from Ceram, a Laughing Kingfisher (*Dacelo gigantea*) from Australia, deposited; six Californian Quails (*Callipepla californica*, 2 ♂ 4 ♀) from California, purchased; a Malaccan Parrakeet (*Palæornis longicauda*, ♂) from Malacca, a Malabar Parrakeet (*Palæornis columboides*, ♂) from Southern India, a Californian Quail (*Callipepla californica*, ♂) from California, a Virginian Colin (*Ortyx virginianus*, ♂) from North America, received in exchange; four Long-fronted Gerbilles (*Gerbillus longifrons*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

MR. TEBBUTT'S OBSERVATORY, WINDSOR, NEW SOUTH WALES.—Mr. Tebbutt, who, it will be remembered, published a short account of his observatory about a year and a half ago (NATURE, vol. xxxvii. p. 400), has resolved to supplement it by a brief annual report, the first of which reports, that for 1888, he has now just issued. The record of his work during the year shows him to have been fully as active as formerly; the list of observations, including, in addition to routine meridian and meteorological work, 56 occultations of stars, besides those of Venus and Saturn, the occultation of 47 Libræ by Jupiter, 75 phenomena of Jupiter's satellites, 230 comparisons of Jupiter and β^1 Scorpii at their conjunction; 164 observations of Pallas on 17 nights, 215 of Comet Sawerthal on 23 nights, 63 of Encke's comet on 10 nights, and 187 of Comet Barnard (1888, September 2) on 20 nights, besides measures of 24 double stars. Faye's comet was seen on December 3, but no determination of place was obtained. The whole of the observations were made by Mr. Tebbutt himself, who has a well-earned reputation for accuracy, and it is with a just and natural satisfaction that he alludes to the use made of his observations by Dr. Kreutz in his discussion of the orbits of the comets of 1880 and 1882, and by Von Haerdtl of that of Winnecke's comet. During the present year, 1889, Mr. Tebbutt proposed to continue observations of the same nature as in 1888, with especial attention to lunar occultations.

THE VARIABLE η ARGÛS.—Mr. Tebbutt mentions in his report the recent increase in light which has been shown by η Argûs, and to which he had already called attention in the *Astronomische Nachrichten*. Dr. Thome now supplements this statement in the same publication, No. 2922, in which he gives the Cordoba observations of the star. From these it appears that the star ran steadily down in brightness from 1871 to 1887, and that since then there has been a fairly rapid recovery, also steady in character. The star has at the same time shown a remarkable change as to colour: before minimum it was a dull scarlet, now it is bright orange; indeed it was the change in colour rather than any increase in brightness which first attracted Dr. Thome's attention. This change he first noticed on March 20, 1887; the last observation previous having been made in July 1886, from whence he infers that minimum fell about October or November 1886. "But if," he adds, "we have here, as seems probable, a type of Mr. Lockyer's binary meteor swarms, March 20 would correspond nearly with the beginning of collisions, and opposition may have occurred years earlier." Dr. Thome estimates the minimum brightness as 7·65; taking the maximum brightness in 1843 as $-1{\cdot}0$ mag. (between Sirius and Canopus), the total range will be 8½ magnitudes in a period of forty-three or forty-four years.

Dr. Thome considers that the observations since 1811, if reduced to the same scale, might no longer show secondary maxima.

THE ROTATION PERIOD OF THE SUN.—Mr. Henry Crew, who published about eighteen months ago (NATURE, vol. xxxvii. p. 495) a determination of the rotation period of the sun by means of the relative displacement of lines in the solar spectrum when observed at the east and west limbs, has recently undertaken a fresh series of observations for the correction or confirmation of those made last year. It will be remembered that Mr. Crew found that his earlier observations gave an increase in the angular velocity with increase of latitude, in opposition to the results obtained by Carrington and others from the observation of sun-spots, and which showed the greatest angular velocity for the equator and its neighbourhood. Mr. Crew now finds that his earlier result needs revision, for there was apparently a systematic error connected in some way with the date of observation. The new series, however, still points to a shorter rotation period for the higher latitudes, the mean value for the rotation period at lat. 45° being 18 hours shorter than at the equator. Having regard to the smallness of this amount and the uncertainty of the observations, Mr. Crew concludes that "no certain variation of period with latitude has been detected by the spectroscope." He calls attention, however, to the wide difference in the values of the equatorial period as obtained by different methods. Hornstein and others, from the variations in the daily range in the barometer, fixed the sidereal rotation period as 24·12 days; Braun and Hornstein, from the variation of the magnetic elements, deduced the values 24·18 and 24·51 respectively; Carrington obtained from sun-spots 24·97 days; Wilsing, from faculæ, 25·23; whilst Crew's value from the spectroscopic method is the longest of all—26·23 days. Mr. Crew makes the suggestion that the different methods really deal with different strata of the sun, and that those portions of the sun which affect the variations of the barometer and of terrestrial magnetism are more deeply seated than the sun-spots, which, again, lie lower than the faculæ, the angular velocity of rotation diminishing on this view from the more central portions of the sun outwards.

COMET 1889 *d* (BROOKS, JULY 6).—The following elements for this comet have been derived by Dr. Otto Knopf from observations made at Mount Hamilton on July 8, Dresden July 30, and Vienna August 19:—

T = 1889 September 26·9997 Berlin M.T.

$\pi - \Omega = 341^\circ\ 56'\ 26''{\cdot}6$
$\Omega = 18\ 14\ 21{\cdot}2$ } Mean Eq. 1889·0.
$i = 6\ 3\ 24{\cdot}0$
$\phi = 28\ 33\ 52{\cdot}4$
$\log q = 0{\cdot}292550$ $\log a = 0{\cdot}575004$.
$\mu = 486''{\cdot}969$ Period = 7·286 years.

Ephemeris for Berlin Midnight.

1889.	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log *r*.	Brightness.
Oct. 4 ..	23 45 57 ...	4 53·6 S....	9·9937 ...	0·2928 ...	2·5
8 ...	23 44 5 ...	4 39·9 ...	0·0003 ...	0·2931 ...	2·4
12 ...	23 42 35 ...	4 24·0 ...	0·0081 ...	0·2935 ...	2·3
16 ...	23 41 28 ...	4 6·1 ...	0·0172 ..	0·2941 ...	2·2
20 ...	23 40 48 ...	3 45·9 S....	0·0273 ...	0·2948 ...	2·1

The brightness at discovery has been taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 OCTOBER 6–12.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on October 6

Sun rises, 6h. 12m.; souths, 11h. 48m. 2·1s.; daily decrease of southing, 17·3s.; sets, 17h. 25m.: right asc. on meridian, 12h. 49·3m.; decl. 5° 18′ S. Sidereal Time at Sunset, 18h. 27m.

Moon (Full on October 9, 1h.) rises, 17h. 5m.; souths, 22h. 17m.; sets, 3h. 42m.*: right asc. on meridian, 23h. 20·0m.; decl. 9° 26′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m. ° ′
Mercury..	8 6 ...	12 50 ..	17 34 ...	13 51·8 ... 15 10 S.
Venus ...	3 5 ...	9 51 ..	16 37 ...	10 52·3 .. 8 25 N.
Mars ...	2 46 ...	9 40 ..	16 34 ...	10 41·3 ... 9 42 N.
Jupiter ...	13 11 ...	17 3 ...	20 55 ...	18 5·0 ... 23 30 S.
Saturn ...	2 0 ...	9 9 ...	16 18 ...	10 9·9 ... 12 41 N.
Uranus...	6 57 ...	12 20 ...	17 43 ...	13 21·5 ... 7 58 S.
Neptune..	19 22*..	3 11 ...	11 0 ...	4 10·8 ... 19 22 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Saturn, October 6.—Outer major axis of outer ring = 37″·9; outer minor axis of outer ring = 6″·3: southern surface visible.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·5 ...	81 17 N. ...	Oct. 10,	3 6	*m*
Algol	3 1·0 ...	40 32 N. ...	,, 7,	0 33	*m*
			,, 9,	21 22	*m*
λ Tauri...	3 54·5 ...	12 11 N. ...	,, 8,	23 51	*m*
ζ Geminorum ...	6 57·5 ...	20 44 N. ...	,, 8,	23 0	*m*
R Ursæ Minoris ...	16 31·5 ...	72 30 N. ...	,, 8,		*m*
R Draconis	16 32·4 ...	66 59 N. ...	,, 9,		*m*
U Ophiuchi... ...	17 10·9 ...	1 20 N. ...	,, 9,	22 24	*m*
R Lyræ	18 52·0 ...	43 48 N. ...	,, 6,		*m*
S Vulpeculæ ...	19 43·8 ...	27 1 N. ...	,, 11,		*M*
U Cygni	20 16·2 ...	47 33 N. ...	,, 9,		*m*
X Cygni	20 39·0 ...	35 11 N. ...	,, 10,	2 0	*M*
T Vulpeculæ ...	20 46·8 ...	27 50 N. ...	,, 9,	20 0	*m*
			,, 10,	22 0	*M*
W Cygni	21 31·8 ...	44 53 N. ...	,, 12,		*M*
δ Cephei	22 25·1 ...	57 51 N. ...	,, 6,	3 0	*m*

M signifies maximum: *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Near γ Persei	44° ...	54° N. ...	Slow.
	103 ...	33 N. ...	Swift; streaks.
	135 ...	80 N. ...	Very swift.

GEOGRAPHICAL NOTES.

THE Hon. Secretary of the South Australian branch of the Geographical Society recently received the following telegraphic message from Mr. Tietkens, who is in command of an Expedition engaged in exploring the interior. The telegram came from Charlotte Waters, and is published by the *Colonies and India*. It says:—"The Expedition under my command arrived at Erldunda on July 22, the party being all well. The Expedition left Glen Edith on May 10. While there for four days and five nights almost incessant rain fell. Forty miles west of Glen Edith we discovered and named Cleland Hills and Gill's Creek, flowing south for twelve miles. The extent of good country is limited. We also discovered and named Beetson Hills, where there were three miles of running water, the extent of available country also being limited. In east longitude 128° 45′ and south latitude 23° 20′, we discovered and named the Kintore Range, the highest peaks of which are Mount Leister and Mount Strickland, 1500 feet above the plains. Here we experienced three days' heavy rains. In south latitude 23° 22′ and east longitude 125° 15′, we discovered and named Lake Macdonald, after the hon. secretary of the Victorian branch of the Society. It extends westerly to east longitude 127° 50′, the south shore being in latitude 23° 40′. South of the Kintore Range we visited and named Davenport Hill, and thence we travelled in a south-easterly direction to Blood's Range, the highest peaks of which were named Mount Harris and Mount Carruthers, being 1400 feet above the plains. Mount Unapproachable, in Long's Range, marks the west extremity to Lake Amadeus, its south shore, south of Mount Olga, being in latitude 24° 39′. At Lake Amadeus the camels partook of a poisonous plant, from the effects of which one died. At Mount Olga the other was unable to travel. After a week's rest the Expedition left there and visited Ayer's Rock. Mr. Goss's marked tree has been burnt down by the blacks. Near Mount Connor we discovered a small spring, and travelling northward from there discovered and named Basedow Range; from there travelled easterly over better country until we arrived here, receiving a most cordial and hospitable reception from Messrs. Warburton and Tomlin. To Mr. Warburton's kindness we are indebted for conveying this message to the telegraph line. The general character of the country passed over has been Spinifex, sand-hills, and plains, with extensive forests of Casuarina. Rock reservoirs, native wells, and a few clay-pans were the only descriptions of water met with."

ONE of the most important of recent exploring Expeditions has been that under Sir William Macgregor, the Administrator of British New Guinea, who has recently ascended and examined the Owen Stanley Range, over 13,000 feet above the sea. Several attempts have been made to reach the summit within the past few years; Sir William therefore deserves much credit, all the more that his natural history observations are very full and valuable. Sir William is an accomplished naturalist, so that any exploring work he may undertake is sure to be of scientific value. He left Port Moresby in May, accompanied by his secretary, and when the Expedition was finally made up there were about forty natives. Only five, however, went up to the top with Sir William, who spent three or four days examining the ridge. The summit was reached on June 11. The climate Sir William describes as foggy and unpleasant up to 8000 feet; but above that clear blue sky and beautiful climate, "one of the finest in the world." The party were ten days over 10,000 feet, and never had a cloud above them. The sea coast was visible on both sides, that on the north being the most distant. But the country is much smoother on that side, and the ascent of the mountain from the north apparently unobstructed and easy. From the point of Mount Victoria in the east to Mount Lilley in the west is a continuous, unbroken crest of thirty miles, which was traversed by Sir William, who spent three days and a half on the summit. His eyes were gladdened by the sight of daisies, buttercups, and forget-me-nots, and he brought away with him a quantity of white heath which reminded him of his native mountains. Big icicles amazed his native companions, who thought their mouths were burnt when they attempted to bite this, to them, novel product of Nature. Larks were plentiful, similar in flight and song to those of the old country. Specimens of the flora were naturally collected by an enthusiastic naturalist like Sir William, and amongst them also probably several novelties will be found. There are no trees within 1000 feet of the top, which is bare rock or covered with grass. There are no snakes or other pests on the main range, but unfortunately game is very scarce also. The temperature ranged from freezing-point to 70° in the sun. The southern aspect of the range is drained exclusively by the Vanapa River, the head of which was crossed at an elevation of 10,130 feet. No natives live on the mountains above 4000 feet, although they hunt as high as 9700 feet. All those met with at the base were extremely friendly. Nothing, however, would induce any of them to accompany the party up the mountain. They grow tobacco, peas, beans, many kinds of potatoes, yams, and bananas, and of these they gave Sir William as much as he wanted. They are certainly Papuan. The party returned to Port Moresby on June 25. Sir William was in perfect health the whole time, though, as usual, the natives had their little complaints. Another account states that Sir William found the top of the crest very uneven, consisting of immense masses of rock separated by deep chasms. The long-tailed bird of paradise was shot at from 5000 to 9000 feet altitude. On the top of one of the mountains what is believed to be a new bird of paradise was obtained, golden yellow on the back, with a black velvet breast and belly. As to the botany, the variety was very small, but what there was was new.

M. YADRINTZEFF's Expedition returned to Kiakhta on August 16, after having reached the sources of the Orkhon River, and determined the position of Kara-korum. It also discovered the ruins of two large cities (one of them having a circumference of thirteen miles), as well as of the palaces of the Khans of Mongolia, and their cemeteries, where numerous statues and important inscriptions were found.

THE BRITISH ASSOCIATION.

REPORTS.

Report (Eighteenth) of the Committee appointed for the purpose of investigating the Rate of Increase of Underground Temperature downwards in various Localities of Dry Land and under Water. Prof. Everett, Secretary.

Very important observations have been published (*Neues Jahrbuch für Mineralogie*, &c., 1889, Bd. 1) during the past year by Herr Dunker, whose observations in a very deep bore at Sperenberg were embodied in our Report for 1876. The new observations were taken at Schladebach, near Dürrenberg, in a bore of greater depth and smaller diameter than at Sperenberg, and with similar precautions against convection currents. The depth was 1748 metres, the bore passing through new red sandstone (Buntsandstein), magnesian limestone (Zechstein), Lower Permian sandstone (Rothliegendes), and coal-measures (Steinkohlengebirge), to the Upper Devonian beds (Oberdevon).

It was tubed to the depth of 1240 metres. For the first 584 metres the diameter was 120 millimetres; for the next 104 m. it was 92 mm.; then for 393 m. it was 72 mm.; and for the next 159 m. it was 50 mm. From this point to the bottom the diameter gradually diminished to that of a man's little finger. The diamond borer was the instrument employed in sinking it.

India-rubber bags, such as were used at Sperenberg for preventing convection currents, being deemed unsuitable for such a narrow bore, a plugging of moist clay was employed, constructed as follows:—

On a cylindrical rod, which might be of tough wood for bores of moderate depth, but was of iron in the actual observations, are two wooden disks of such size that there is only just room for them to move in the bore. The lower disk is fixed, and the upper movable on the rod. The part of the rod below the fixed disk has a length equal to that of the water-column which it is desired to isolate. The maximum thermometer with which the temperatures are taken has its bulb half-way down this portion of the rod. It is fastened beside the rod if there is room for it; and when the bore is too narrow for this arrangement, the thermometer is placed in a metal box which may be described as forming part of the rod, the rod being divided into two portions screwed to the two ends of the box. The movable disk is re-

moved to a measured distance from the fixed one, and the space between them is then filled with clay which has been made plastic by kneading it with water, so that it forms a cylinder with the two disks.

When the pole presses on the bottom of the bore, part of the weight of the boring rods is supported on the upper disk, thus squeezing the clay against the sides of the bore and forming a water-tight plug.

The above description applies especially to the taking of observations at the bottom of the bore. When it was desired to isolate a column of water at a considerable distance from the bottom, the apparatus employed consisted of two portions. The above description applies to the upper portion, and the lower portion was similar to it but inverted, resting upon rods which extended to the bottom. The two masses of clay in this case cut off a water-column between them.

Experiments with a model, in which the bore was represented by a cylindrical glass vessel 26 cm. high and 55 mm. wide, filled with water, showed that the isolation was very good, and that it remained so though the immersion lasted more than ten hours. In tearing away the clay from the vessel a portion of the clay fell into the water, but such an accident occurring in the bore would be of no consequence.

The construction of the isolating apparatus was intrusted to Bore-Inspector Köbrich, under whose management the observations were to be carried out.

Besides the thermometer in the isolated water-column, there was a second maximum thermometer in the open water just above the upper plug, for comparison, the height of its bulb above that of the principal thermometer being 2·8 m.

The thermometers were very similar to those employed at Sperenberg. They were overflow-thermometers, generally without scales, and were inclosed (for protection against pressure) in a hermetically sealed case of stout glass with an external diameter of 15 mm. To take the reading, the thermometer, after being drawn up, was put with a normal thermometer into a vessel of water at a temperature a little below that which was expected. Warm water was then gradually added, and the whole kept stirred till the mercury in the overflow-thermometer reached the open end. The temperature at this moment was then read by the other thermometer.

The first observations taken were in the untubed portion of the bore, which at that time extended from the depth of 1240 m. to 1376 m.; and as the bore was deepened to 1748 m. the observations were continued. In this way the last sixteen observations of Table I. were obtained, forming a series at intervals of 30 m. from 1266 m. to 1716 m. of depth.

A pause which subsequently occurred in the sinking of the bore, through having to wait for a new tube, was utilized for taking the observations which form the remainder of the table. We have thus a complete series of observations, at equal intervals of 30 m., from the depth of 6 m. to that of 1716 m.: 8°·3 R. at 6 m., and 45°·3 R. at 1716 m.

The table is arranged in five columns. The first column contains the natural numbers from one to fifty-eight, for convenience of reference to the observations at the fifty-eight different depths; the second column contains the depths in metres; and the third column, the temperatures observed at these depths in isolated water-columns. The fourth column contains the excess of the temperature so observed above the temperature observed by means of the secondary thermometer in the free water just above the plug. The fifth column contains the differences between the successive numbers in the third column—in other words, the increase of temperature for each 30 m. of depth.

The smallness of the effect of isolation, as shown in the fourth column of the table, is very noteworthy, its greatest value being 1° R., and its average value about ¼ of 1° R. At Sperenberg it amounted in several cases to about 3° R. The smallness of the effect in the present case is attributable to the narrowness of the bore, which tells in two ways: there is more frictional resistance to the movement of the water; and the thermal capacity of a given length of column is less in comparison with its surface of contact with the sides of the bore.

As a further experiment on the prevention of convection, a wooden plug was driven into the bore at the depth of 438 m., thick mud was introduced till it filled all the bore above this plug, and observations were taken with a maximum thermometer in the mud at depths from 426 m. to 126 m. A second plug was then driven in at the top of the tubing, which was 120 m. beneath the surface of the ground, and the observations were continued upwards from 118 m. to 6 m. The observations thus taken in the mud are given. They are rather higher than those previously obtained at the same depths, the greatest difference occurring at the depth of 276 m., where it amounts to 0°·9 R. Herr Dunker suggests that the difference may have arisen from insufficient time being allowed for the mud to take the permanent temperature.

Upon the whole it is clear that in this great bore the disturbing effect of convection is very small, and that, such as it is, it has been almost annihilated by the very efficient system of plugging adopted. The series of observations now before us, extending as it does by regular stages from the surface to a depth of 5630 feet, in a new bore where there has not been time for the original heat to be lost by exposure, forms undoubtedly the most valuable contribution ever made to the observation of underground temperature. The official to whose initiative the observations are due is Chief-Mining-Captain Huyssen, of Berlin. The expense of sinking the bore was £10,000 sterling, the time required for hauling up the boring rods was ten hours, and their united weight was 20 tons.

On plotting the temperatures so as to exhibit temperature as a function of depth, the curve obtained approximates very closely to a straight line. A straight line joining its two ends meets the curve several times in the part corresponding to the tubed portion of the bore, which is about three-fourths of the whole; while in the remaining fourth (forming the deepest portion of the bore) all the temperatures except the first and last lie above the straight line. In this statement it is to be understood that depth is represented by distance laid off horizontally, and temperature by distance laid off vertically upwards.

The question whether the curve on the whole bends upwards or downwards is of some interest, because it is equivalent to the question whether the rate of increase is accelerated or retarded as we go deeper. The evidence on this point is undecisive. The curve for the untubed portion, from 1266 m. to 1716 m., lies slightly above its chord; but the curve from either 6 m. or 36 m. to 1500 m. lies for the most part below its chord.

Taking the observation at 36 m. as the first which is free from atmospheric disturbance, and comparing it with the deepest observation of all, which is at 1716 m., we have an increase of 36°·5 R. in 1680 m. This is a difference of 82°·1 F. in 5512 feet, which is at the rate of 1° F. in 67·1 feet.

Herr Dunker, after an elaborate discussion of the question whether the curve on the whole bends upwards or downwards, arrives at the conclusion that it is best represented by a straight line. He applies the method of least squares to find the slope of this straight line, on the assumption that it passes accurately through the point determined by the observation at 36 m., and he thus obtains a mean rate of increase of 0·0224276 of a degree Réaumur per metre, which is equivalent to 1° F. for 65·0 feet.

The Secretary has been in correspondence with Mr. George Westinghouse, Jun., of Pittsburg, President of the Philadelphia Company, with the view of obtaining observations of temperature from some of the deep oil and gas wells belonging to the Company. Mr. Westinghouse has purchased three of the Committee's maximum thermometers, and has intrusted the taking of the observations to Mr. A. Cummins, the Company's Mining Engineer and Geologist. Some attempts have been made at observation, but owing to press of business they have not been thoroughly carried out. Mr. Cummins states that "there has been a constant strain to bring up the supply of gas to the requirement of the city's needs, and every hour of delay is watched very jealously."

The most successful attempt was made in a well at Homewood, in the city of Pittsburg, known as the Dilworth well, where the following results were obtained:—

Depth in feet.	Temperature F.	Air at surface.
	°	°
3600	96	70
3710	89	76
3920	102	60
4002	108	62
4215	111	62
4295	114	62

The well was sunk to a depth of 4625 feet, but no observations were made except at the depths specified. The thermometer remained only from five to ten minutes during each test; and as there were only 40 feet of water in the well, the observations

must have been taken in air. The diameter of the well was 6 inches. The rock was chiefly slate, and was bored by "jumping." The mean air temperature at Pittsburg is 52° F., and the height above sea-level about 900 feet. Comparison of the mean surface-temperature (taken as 52°) with the temperature 114° recorded at 4295 feet shows an increase of 62°, which is at the rate of 1° F. for 69·3 feet; but comparisons of the observations *inter se* would give a rate about twice as rapid as this; hence no safe conclusion can be drawn. After the hurry and worry of the gas business is over, Mr. Cummins hopes to get the temperature of some deep wells in a way that will be satisfactory.

We may mention, as a contribution to the literature of underground temperature, the recent publication of results obtained at the Old Observatory, Allahabad, with thermometers whose bulbs were at the depths 3 feet, 1 foot, and ½ inch respectively. Harmonic reduction has been applied to deduce both the annual and the diurnal variation, and from the former a fairly consistent determination of "diffusivity," or quotient of conductivity by capacity, has been obtained. Its value, 0·0054 C.G.S., is smaller than any values that have been found elsewhere. The soil is a sandy loam, which in dry weather becomes almost as hard as brick. The observations extend over six years, and similar observations are now being carried on at the New Observatory. The gentleman who is responsible for the reductions and the description of the observations is Mr. S. A. Hill, B.Sc., Meteorological Reporter to the Government for the North-West Provinces.

Report of the Committee appointed for the purpose of investigating the Best Methods of ascertaining and measuring Variations in the Value of the Monetary Standard. Prof. Edgeworth, Secretary.

This consists of a Supplementary Memorandum by the Secretary, designed as a supplement to the Memorandum appended to the First Report of the Committee. The object of that Memorandum was to distinguish the different definitions which the proposed problem might present; and to construct the formula appropriate to each phase of the investigation. The analysis of contents is as follows:—(1) Prof. Newcomb's method; (2) Prof. Foxwell's method; (3) Mr. Giffen's methods; (4) Mr. Bourne's method; (5) Sir Rawson Rawson's method; (6) Prof. Edgeworth's method; (7) Ricardo's method.

The conclusion of the Memorandum runs as follows:—

It may be useful to enumerate and summarily characterize the principal definitions of the problem, or "standards,"[1] which have been discussed in this and the preceding Memorandum. An alphabetical order will be adopted, the order of merit being not only invidious, but also impossible in so far as different methods are the best for different purposes.

1. The *capital standard* takes for the measure of appreciation or depreciation the change in the monetary value of a certain set of articles. This set of articles consists of all purchasable things in existence in the community, either at the earlier epoch or at the later epoch, or some mean between those sets. This standard is due to Prof. Nicholson. It is stated by him (in terms a little less general than those here adopted) in his book on "Money." It is discussed in the sixth and the tenth sections of the former Memorandum.

2. The *consumption standard* takes for the measure of appreciation or depreciation the change in the monetary value on a certain set of articles. This set of articles consists of all the commodities consumed yearly by the community either at the earlier or the later epoch, or some mean between those two sets. This standard has been recommended by many eminent writers, in particular by Prof. Marshall in the *Contemporary Review* of 1887. It is proposed by the Committee as the principal standard. It is discussed in the second section of the former Memorandum.

3. The *currency standard* takes as the measure of appreciation or depreciation the change in the monetary value which changes hands in a certain set of sales. These sales comprise all the commodities bought and sold yearly at the earlier epoch or at the later epoch, or some mean between those quantities. This standard appears to be implicit in much that has been written on the subject, but to have been most clearly stated by Prof. Foxwell. It is discussed in the second section of this Memorandum.

[1] The methods discussed in connection with the names of Mr. Giffen, Mr. Bourne, and Sir Rawson Rawson are rather solutions than statements of the problem.

4. The *income standard* takes as the measure of the appreciation or depreciation the change in the monetary value of the average consumption, or in the income per head, of the community. This standard is proposed in the fourth and fifth sections of the former Memorandum.

5. The *indefinite standard* takes as the measure of appreciation or depreciation a simple unweighted average of the ratios formed by dividing the price of each commodity at the later period by the price of the same commodity at the earlier period. The average employed may be the arithmetic mean used by Soetbeer and many others, or the geometric mean used by Jevons, or the median recommended by Prof. Edgeworth. This standard is recommended by the practice of Jevons[1] and the theory of Cournot.[2] It is discussed in the eighth and ninth sections of the former Memorandum, and the fifth section of the present one.

6. The *production standard* is a designation which may be applied to a method which is related to the currency standard very nearly as the income standard is related to that based on consumption. The production standard takes as the measure of appreciation or depreciation the change in the monetary value *per head* of the total amount of things produced in the community yearly. This standard is proposed by Prof. Simon Newcomb in his "Political Economy." It is discussed in the first section of this Memorandum.

7. The *wages* (and *interest?*) *standard* takes as the measure of appreciation or depreciation the change in the pecuniary remuneration of a certain set of services—namely, all (or the principal) which are rendered in the course of production, throughout the community, during a year, either at the initial or the final epoch; or some expression intermediate between the two specified. The theoretical basis and practical construction of such a standard are indicated in Ricardo's "Principles of Political Economy" (ch. xx. and elsewhere), in Prof. Marshall's evidence before the Gold and Silver Commission ("Parliamentary Papers," 1888, C.), and in the papers contributed by Mr. Giffen to the second volume of the Bulletin of the International Statistical Institute. The standard is discussed in the last section of this Memorandum.

Report (Second) of the Committee appointed for the purpose of reporting on the present state of our knowledge of the Zoology and Botany of the West India Islands, and taking steps to investigate ascertained deficiencies in the Fauna and Flora. Mr. D. Morris, Secretary.

This Committee was first appointed in 1887, and re-appointed in 1888. At a meeting held on December 5, 1888, it was decided to invite the co-operation of Dr. Günther, F.R.S., a member of the sub-committee appointed for a similar purpose by the Government Grant Committee of the Royal Society, and Colonel

[1] Most of Jevons's celebrated calculations ("Currency and Finance," ii., iii., and iv.), and in particular his calculation of the probable error incident to his result (*ibid.* p. 157), involve this conception.

[2] Cournot has considered our problem in each of the five volumes in which he has treated of, or touched on, political economy ("Dictionary of Political Economy," Art. "Cournot"). It is sufficient here to refer to the first and the last of those works, the "Recherches" of 1838 and the "Revue Sommaire" of 1876—the Alpha and almost the Omega of economic wisdom. From these it is clear that variation in the "absolute" or "intrinsic" value of money, in Cournot's view, corresponds to the "indefinite standard" as defined in Section viii. of the predecessor to this Memorandum. Cournot illustrates the variation due to a change on the part of money, by that change in the position of the earth with respect to the stars, which is due to the motion of the earth. In this analogy the stars are treated as "points" ("Recherches," Art. 9). No account is taken of their mass. The context shows that Cournot contemplates a simple average of distances between the earth and each star; not a *weighted* average, or the distance between the earth and the *centre of gravity* of the stars. In his later works he expressly declares against, or at least thinks unbefitting highest place, the measure of what he calls the "power of money" ("Revue Sommaire," Sect. 3), that is, in our terms, the consumption standard; the analogy of which is the distance of the earth from the *centre of gravity* of the stars, or rather of certain select stars—say those which are nearest to our human sphere. The currency standard, of which the analogy is the distance of the earth from the *centre of gravity* of all stars whatever, does not seem to have been entertained by Cournot.

Cournot, alluding to Jevons's treatment of the problem in "Money," not unjustly takes him to task for not having distinguished "assez nettement" variations in the "intrinsic value of money" (of which the measure is our indefinite standard) from variations in the "power of money" (of which the measure is our consumption standard) ("Revue Sommaire," p. 121). Referring to Jevons's proposal to construct a *tabular standard of value*, Cournot expresses his approbation in words which may fittingly conclude the present study:—"Ce sont là des idées qu'il faut laisser mûrir. Quand le moment sera venu de construire effectivement *l'étalon monétaire*, les géomètres pourront y trouver une application intéressante de leur *théorie de moyennes*, telles qu'ils l'ont déjà construite pour les besoins de l'astronomie et de la physique."

Feilden, of the Army Pay Department, at that time acting as Local Secretary to the Committee at Barbados.

The services of Mr. G. A. Ramage were retained as collector at Dominica and St. Lucia, and several collections were received from him during the past year. Owing to ill-health Mr. Ramage returned to this country in June last, and he has now retired from the post of collector to the Committee. Mr. F. Du Cane Godman has generously assisted the work of the Committee by sending out, at his own expense, the well known naturalist and collector, Mr. H. H. Smith, to the Island of St. Vincent, to make collections in as many branches as possible of natural history. These collections have not yet reached this country, but it is anticipated that they will prove of considerable value.

Colonel Feilden obtained numerous botanical and zoological specimens in Barbados and the neighbouring islands. He has published a paper on the reptiles, and another on birds; papers on the Mammalia and land Mollusca will follow. He also obtained a living specimen of the green monkey of Western Africa, which has become feral in Barbados (*Cercopithecus callitrichus*). This was presented by the Committee to the Zoological Society of London.

Dr. H. A. Alford Nicholls, Local Secretary to the Committee at Dominica, has rendered valuable assistance, and he will be engaged for six weeks this autumn in exploring Montserrat and the isolated rock called Redonda, which is a dependency of Antigua.

The particulars of the collections received during the past year are as follows:—

Zoology.—The zoological specimens obtained by the Committee up to June 1889, including those collected by Mr. Ramage in Dominica and St. Lucia, have been placed in the hands of specialists for examination and determination. Mr. Oldfield Thomas has determined the Mammalia, Dr. Sclater the birds; Dr. Günther has published a paper on the reptiles, Mr. E. A. Smith three papers on the Mollusca, Mr. R. I. Pocock two on the Myriopoda and Crustacea, and Mr. Kirby one on the Phasmidæ.

Botany.—The botanical specimens collected by Mr. Ramage in Dominica and St. Lucia, up to May 1889, have been determined at Kew; the flowering plants by Mr. R. A. Rolfe, the ferns by Mr. J. G. Baker, and the cellular cryptogams by Dr. Cooke and Mr. C. H. Wright.

From Dominica about 394 species were received, of which (excluding the cryptogams) about 40 could only be provisionally determined; and of these a few, perhaps about half, are probably undescribed. The great majority belong to already well-known species, most of which were previously known from the island.

From St. Lucia about 189 species have been sent, of which (excluding the cryptogams, as before) over 30 were not determined, and possibly about half of these may prove to be undescribed. This island was less completely known than Dominica, and several additions to our knowledge of its flora have been made by Mr. Ramage. During the working up of the collections a strong affinity with Dominica, and perhaps still more so with Martinique, has become apparent. From the latter island large collections are well represented at Kew, though the materials have never been thoroughly worked up.

The specimens which it was not found possible to determine belong for the most part to large genera of woody plants, as Guttiferæ, Leguminosæ, Myrtaceæ, Myrsineæ, Laurineæ, and a few others, which renders it the more probable that a fair proportion of them may prove undescribed.

The number of novelties is perhaps not so great as was originally expected, and this may arise either from the ground having been worked over before, or, what is perhaps more probable, from the fact that a considerable uniformity prevails in the flora of this chain of islands, with a corresponding paucity in endemic types.

The Committee would draw particular attention to the botanical and zoological bibliography of the Lesser Antilles prepared under its direction, and published as an appendix to the Report for 1888. This bibliography has been widely distributed in the West Indies and in Europe, and has proved of considerable service in carrying out the objects for which the Committee was appointed.

Report (Fifth) of the Committee appointed for the purpose of considering the best means of Comparing and Reducing Magnetic Observations. Prof. W. Grylls Adams, Secretary.—The Committee report the establishment of regular magnetic observatories, where continuous photographic records of the magnetic elements are taken, at the United States Naval Observatory at Washington, and also at Los Angelos in California. The instruments used are of the Kew pattern, with the same time-scale, and the scale-coefficients for horizontal and vertical force instruments at Washington are very nearly those recommended by the Committee in their Third Report (1887), and which are in very near agreement with those at Vienna, St. Petersburg, and some other observatories. The Committee report, further, that the plan proposed by them in their Third Report for the Comparison and Reduction of Magnetic Observations, has been adopted at the United States Naval Observatory at Washington, which is now prepared to take part in the general scheme of co-operation proposed by the Committee. Copies of the photographic registers of the three elements for April 21–30, May 1–31, and for June 1–30 have been forwarded to the Committee from Washington, with tables of scale and temperature coefficients. There are also forwarded two prints showing the reduction of the declination for the year 1888, by means of a graphic composite curve, made by tracing over one another with a pantograph the daily curves of the month, and then drawing a curve through them to show the monthly means. There are also forwarded from Washington a set of prints showing the comparison of the disturbances of declination and horizontal force at Washington for ninety-nine days of 1888, and another set of prints showing the comparison of disturbances of declination on certain selected days at Washington, Los Angelos, and Toronto, all reduced to the same time-scale of 30·6 mm. for two hours, *i.e.* the time-scale of instruments of the Kew pattern. The Committee are more than ever of the opinion expressed in their Third Report, "that the establishment of regular magnetic observatories at the Cape of Good Hope and in South America would materially contribute to our knowledge of terrestrial magnetism." The Committee consider that it would be desirable to publish annually in a collected form for certain selected days the curves of the three magnetic elements, *i.e.* declination, horizontal force, and vertical force, taken at the different English and Colonial Magnetic Observatories, choosing for selection in 1888 the days for which the curves are published in the "Greenwich Observations."

Report (Fourth) of the Committee appointed for the purpose of promoting Tidal Observations in Canada. Prof. A. Johnson, Secretary.—The Committee refer to a previous Report, in which it was announced that the then Minister of Marine (the Hon. G. Foster) had directed that some preliminary investigations should be made by Lieut. Gordon, R.N., who was to put himself in communication with Prof. Darwin. The Minister, however, said that the existing expenditure on hydrographic surveys made it necessary to postpone for the time the consideration of further steps concerning tidal observations. The Committee was reappointed last year to keep the subject before the notice of the Government, in the hope that this systematic tidal work would be begun this year. In May last an interview was obtained with the Hon. C. Tupper, the present Minister of Marine, at which Sir Wm Dawson was present. The Minister expressed himself as entirely favourable to the institution of the proposed tidal observations, but said that the financial position as regards the expenditure on hydrographic surveys was the same as last year, and that therefore no further steps could be taken as yet in the matter. It is believed that since the interview some of the expenditure in hydrographic surveys has ceased, and as there is reason to believe that other Cabinet Ministers are in favour of the proposed measure, the Committee deem the prospects of carrying it into execution very satisfactory. There is no doubt about the anxiety of shipmasters to have the tidal investigations set on foot immediately, and the Royal Society of Canada deem the matter of such great practical importance, that at their last meeting they appointed a special Committee to give energetic support to the action of this Committee.

Report of the Committee appointed for the purpose of continuing the Inquiries relating to the Teaching of Science in Elementary Schools. Prof. Armstrong, Secretary.—This year has been one of continued depression in regard to the teaching of science in elementary schools, and of disappointment in regard to legislative action. The return of the Education Department for this year shows again a diminution in the teaching of the science subjects. The statistics of the class subjects for six years are given, and show an actual decrease in ele-

mentary science, and a comparative decrease in geography. The return of scholars individually examined in the scientific specific subjects shows an actual or relative falling off in every subject except mechanics and chemistry. The rapid and serious decrease of attention paid to these science subjects is shown by the percentage of children who have taken them, as compared with the number of scholars that might have taken these subjects, viz :—In 1882–83, 29·0 per cent.; in 1883–84, 26·0 per cent.; in 1884–85, 22·6 per cent.; in 1885–86, 19·9 per cent.; in 1886–87, 18·1 per cent.; in 1887–88, 16·9 per cent.; and it must be remembered that children who have taken two of these subjects count twice over. The Government laid upon the table of the House a new Code, which would have had a slightly beneficial effect upon the teaching of science; but it has been entirely withdrawn. The Government has introduced no Technical Instruction Bill this year—except just at the last moment—and that does not apply to "scholars receiving instruction in an elementary school in the obligatory or standard subjects prescribed by the minutes of the Education Department." It was hurried through the Committee and final stages during the last week of the session. Sir Henry E. Roscoe, however, reintroduced his Bill with some modifications, and it passed the second reading at a comparatively early period of the session; but the Government would only give facilities for its progress through the House on the understanding that very serious changes were to be made in it. As he could not accept these, it has not passed the Committee stage; and it was ultimately withdrawn. Mr. Samuel Smith has again brought in a Continuation Schools Bill; but there has been no opportunity of discussing it since the first reading, and it was therefore withdrawn. The subject has, however, grown in the estimation of the public; and the whole question of the teaching of science in State-aided schools requires to be pressed more and more upon the Legislature.

Report of the Committee on Electrical Standards. R. T. Glazebrook, F.R.S., Secretary. (Slightly abridged.)

The Committee report that the work of testing resistance coils has been continued at the Cavendish Laboratory. A table of the values found for the various coils is given. Further steps have been taken towards the construction of an air condenser. As stated in the last Report, Dr. Alexander Muirhead kindly placed at the disposal of the Committee, for the purpose of experiment, three such condensers which he had constructed. A series of tests of these condensers was carried out by the Secretary and laid before a meeting of the Committee in London on April 15. It was then decided to adopt Dr. Muirhead's form of condenser for the new instruments of the Committee, and two instruments, each having a capacity of 0·01 microfarad, have been ordered from the Cambridge Scientific Instrument Company. They are not yet finished; a detailed description of their design is therefore left to the next Report.

A second subject of investigation has been the specific resistance of copper. During the year Mr. T. C. Fitzpatrick has made a large series of experients to determine this, and the Committee desire to thank cordially those manufacturers and others who have given their assistance in this research. Before publishing his results, Mr. Fitzpatrick is desirous of experimenting on some copper which is being prepared for him by chemical means—all which has been used hitherto has been electrically deposited—and of attempting still further to purify some of the copper already in his possession. Two members of the Committee, Sir W. Thomson and Mr. Preece, were present at the recent Electrical Congress in Paris. As an English equivalent of the resolutions there passed, the Committee have adopted the following resolutions, which they hope will meet with general acceptance :—

(1) The name of the practical unit of work shall be the joule.

The joule is equivalent to 10^7 C.G.S. units of work. It is the energy expended during 1 second by a current of 1 ampere when traversing a resistance of 1 ohm.

(2) The name of the practical unit of power shall be the watt.

The watt is the rate of working of a machine performing 1 joule per second. The power of a machine could naturally be expressed in kilowatts instead of in horse-power.

(3) The name of the practical unit of light intensity shall be the candle.

The candle is equal to the twentieth part of the absolute standard of light as defined by the International Conference of 1884.

(4) The name of the practical unit of induction shall be the "quadrant." 1 quadrant is equal to 10^9 cm.

(5) The "period" of an alternating current is the duration of a complete oscillation.

(6) The "frequency" of an alternating current is the number of complete oscillations per second.

(7) The "mean current" through a circuit is the time average of the current, and is defined by

$$\text{mean current} = \frac{1}{T}\int_0^T i\,dt,$$

i being the current at each instant of the time T.

(8) The effective current is the square root of the time average of the square of the current. Thus

$$\text{effective current} = \sqrt{\left\{\frac{1}{T}\int_0^T i^2 dt\right\}}.$$

(9) The effective electromotive force is the square root of the time average of the square of the electromotive force. Thus

$$\text{effective electromotive force} = \sqrt{\left\{\frac{1}{T}\int_0^T e^2 dt\right\}},$$

e being the actual electromotive force at each instant of the time T.

(10) The impedance is the factor by which the effective current must be multiplied to give the effective electromotive force. Thus, in the case of a circuit of resistance R ohms, and self-induction L quadrants in which a simple harmonic electromotive force of frequency $\frac{n}{2\pi}$ is acting, impedance $= \sqrt{R^2 + L^2n^2}$.

(11) In an accumulator the positive pole is that which is connected with the positive pole of the machine when charging, and from which the current passes into the external circuit when discharging.

The Committee are of opinion that they should be reappointed with the addition of the name of Prof. J. Viriamu Jones.

Report on the Present State of our Knowledge in Electrolysis and Electro-chemistry. By Mr. W. N. Shaw.

The following is an abstract :—

I. General electrolytic phenomena.

For a typical specimen we cannot suppose an electrolytic liquid otherwise than a mixture of solutions of chemical compounds, though the amount of all but one constituent of the mixture may be so small as to be regarded merely as impurities which it would not even be possible to detect by ordinary chemical means; thus von Helmholtz said in his Faraday lecture he has detected the polarization corresponding to the decomposition of a quantity of water of the order 1×10^{-11} gramme, and Gore (Proc. Roy. Soc., June 14, 1888) has shown the effect of chlorine upon the E.M.F. of a zinc platinum voltaic couple in distilled water is such that the presence of one part of chlorine in 1000 million parts of water could be detected thereby. Pure water, since Kohlrausch's experiments, is now looked upon as probably not conducting at all. Ratio of conductivity to that of mercury $= 0{\cdot}71 \times 10^{-10}$ at 21°·5 C., and its sensitiveness to small quantities of impurity approximated to that of the sense of smell, since, when exposed in a room containing tobacco smoke, its conductivity doubled in three hours.

II. Laws and principles generally accepted.

(*a*) The electro-magnetic action of the current passing through an electrolyte is the same as if the electrolyte were replaced by a metallic conductor of the same size and shape and of such resistance that it could be substituted for the electrolyte without altering the current in the rest of the circuit.

(*b*) There are electrolytes in which the conduction of electricity from the electrode to the electrolyte, and again from the electrolyte to the electrode is entirely "convective" in the sense that no electricity can pass into an electrolyte or out of it again without causing a deposit of a certain number of constituent ions at the anode and the opposite ions at the kathode, *i.e.* in certain electrolytes no conduction takes place without chemical decomposition. This holds for a large number of electrolytes, possibly for all. It is not yet substantiated that it is true for all electrolytes, but the evidence is continually accumulating in that direction.

(*c*) The conduction of electric currents through electrolytes follows Ohm's law. Reference is made to Crystal's experiments on metallic conduction, and Fitzgerald and Trouton's on electrolytic conduction.

One point is the experimental evidence for the deduction from Maxwell's theory of light, that electrolytes being transparent should behave as dielectrics for rapidly alternating electromotive forces. There are two ways of approaching the question—

(1) To find the length of light wave for which electrolytes are opaque.

(2) To find the rapidity of electrical vibration for which the electrolytes cease to conduct.

With reference to (2), Prof. J. J. Thomson says electrolytes still conduct when the rapidity of alternation is 300 millions per second.

(*d*) The only immediate effect of the passage of the current upon the body of a homogeneous electrolyte is to alter the temperature, and the alteration of temperature takes place in accordance with Joule's law.

Full references to the literature of the subject are given in the Report.

Report of the Committee appointed to make a digest of the Observations on Migration of Birds at Lighthouses and Light-vessels which have been carried on during the past nine years by the Migrations Committee of the British Association. Mr. John Cordeaux, Secretary.—The Committee have to report that one of their number, Mr. W. Eagle Clarke, of the Museum of Science and Art at Edinburgh, has, with the approbation of the Committee, undertaken to prepare the digest of the observations; and all the materials for making the same, including 1500 skeleton maps of the British Islands, provided for the purpose, have accordingly been placed in his hands. The labour of reducing the observations, to show in a concise form and on strictly scientific lines the results of the investigation which was carried on from 1879 to 1887 inclusive, will be easily understood to be enormous; and when it is borne in mind that this heavy work can only be carried on after official hours, your Committee feel that no apology is necessary for the non-completion of the digest this year.

Report of the Committee appointed to arrange an Investigation of the Seasonal Variations of Temperature in Lakes, Rivers, and Estuaries in various parts of the United Kingdom in co-operation with the Local Societies represented on the Association. Dr. H. R. Mills, Secretary.—It is inadvisable to attempt at present to summarize the results of observations made, as although more than a year's observations are available on some rivers, it is only a few months since the work has been begun on others. At the end of another year it is expected that sufficient data will be found to justify a comprehensive report on the subject. Several members of the Committee have taken much trouble in collecting observations. Dr. Sorby has been good enough to collect and discuss a great mass of temperature observations which he had made from his yacht *Glimpse*, in the estuaries of the south-east of England during the summer months of five successive years. This will be published separately. Prof. Fitzgerald took charge of the observations in Ireland, where he induced a number of observers to take up the work. Mr. Willis Bund had already inaugurated similar researches on the Severn. Rev. C. J. Steward and Mr. Isaac Roberts rendered important services in their districts. A circular was sent to all the Corresponding Societies in connection with the Association, requesting their co-operation, and favourable replies were received from several, intimating that observations had been commenced. The instructions issued to observers are given as an appendix to the present Report.

Report of the Committee on Solar Radiation.—The actinometer devised by the late Prof. Balfour Stewart, for the continuous measurement of solar radiation which was described in the Report of the Association for 1887, is now ready for preliminary trials, the internal thermometer with a flat bulb of green glass having been made since the date of that Report. The construction of this thermometer occasioned a good deal more trouble than had been anticipated. No attempt has at present been made to render the instrument self-recording, as it would obviously be unwise to incur the outlay which any construction for this purpose would involve, until the result of preliminary trials was such as to encourage a hope that the instrument might really be useful if rendered self-recording.

Report of the Committee appointed for the purpose of taking steps for the Investigation of the Natural History of the Friendly Islands, or other Groups in the Pacific visited by H.M.S. "Egeria." Mr. S. F. Harmer, Secretary.—The Committee have not yet received information which puts them in a position to give any detailed report of the work which is being done in connection with the above subject. The grant has been paid to Mr. J. J. Lister, who reached Tonga on March 19. After devoting two months to the investigation of the natural history of that group, Mr. Lister joined H.M.S. *Egeria*, on her arrival at Tonga, with the intention of visiting Samoa, where, by the latest accounts, he was carrying on his researches.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE thirty-eighth annual meeting of this body was held in the fourth week of August at Toronto, Canada. This is the third time in the history of its existence that the meeting-place selected has been on British territory—the first and second being at Montreal in the years 1857 and 1882.

The arrangements for the entertainment of the visitors were all of that free, open-handed, generous character peculiar to New-World hospitality. A large and representative Local Committee was appointed, and through their instrumentality many facilities for comfort and pleasure were obtained; such, for example, as reduced railway fares, the withdrawal of all Customs duties on instruments, specimens, &c., for use at the meetings, a daily luncheon given gratis at the place of meeting, excursions at reduced rates to Niagara, to the Muskoka Lakes, to the Huronian district, and even across the continent to the Pacific coast. There were also the usual number, or perhaps even more than the usual number, of garden parties, evening entertainments, and small excursions to outlying localities of geological, entomological, or botanical interest. Two public lectures were also given, the subject of the first being the evolution of music, of the second, the geological history of Niagara.

Among those present who took an active part in the proceedings were Prof. James D. Dana; Sir Daniel Wilson, the President of University College, in the Convocation Hall and Lecture Rooms of which the majority of the Sections met; Sir William Dawson, of Montreal; Dr. Charles C. Abbott; Prof. N. H. Winchell, of Minneapolis; Major J. W. Powell, of Washington, the retiring President; T. C. Mendenhall, of Washington, the President for this year; Messrs. Carpmael, Ramsay, Wright, and London, of University College; Profs. Hall and Newberry, who, with Prof. Dana, were the first three Presidents of the Association; Mr. Macoun; Dr. T. Sterry Hunt; Prof. Alexander Winchell, author of "World Life"; Prof. Heilprin, author of "The Geographical and Geological Distribution of Animals," &c.; Messrs. Minot, Morse, Newton, and many others of note. Nor must be omitted the names of Mr. F. W. Putnam, the permanent Secretary; and the following Vice-Presidents of the Association: R. S. Woodward, H. S. Carhart, W. L. Dudley, J. E. Denton, C. A. White, G. L. Goodale, Colonel G. Mallery, and C. S. Hill.

Many sincerely regretted the absence of the learned and genial Professor E. J. Chapman, of University College.

Not much time was wasted at the first meeting in the inevitable speeches and addresses of welcome, and within a couple of hours of the time when the general session was called to order by the venerable Professor Dana, on Wednesday morning, August 28, the various Sections met to organize, preparatory for the delivering in the afternoon of the Vice-Presidential addresses—the Vice-Presidents of the Association being chosen from, and acting as Presidents of, the several Sections.

The majority of these addresses were of a general or historical character. Mr. Carhart, in the Section of Physics, reviewed the theories of electrical action; Mr. Goodale, in the Biological Section, spoke of protoplasm; in the Department of Anthropology, Colonel Mallery dealt with the somewhat curious and little heard of, though not novel, theory of the Hebrew origin of the Indians of North America, discussing the arguments in behalf of that theory, especially the very problematical ground that the plane of civilization and thought of the Indians of to-day was parallel to that of the Israelites of the Old Testament.

Section of Anthropology.

A very large number of the papers read in the Section of Anthropology quite naturally referred to the Indians of the American continent. The following is a list of the more important of these:—

The Huron-Iroquois, by Sir Daniel Wilson.

Evidences of the Successors of Palæolithic Man in the Delaware River Valley, by Dr. Charles C. Abbott.

The Winnipeg Mound Region, by Dr. George Bryce, of the Winnipeg College.

New Linguistic Family in California, by H. Henshaw.

Onodaga Shamanic Masks, by De Cost Smith (Onodaga is a county in the State of New York).

The Phonetic Alphabet of the Winnehago Indians, by Miss Alice C. Fletcher.

The Medawiwin or Grand Medicine Society of the Ojibway, by W. J. Hoffman.

Notes on Aboriginal Fire Making, by Walter Hough.

Aboriginal Mounds of North Dakota, by Henry Montgomery.

The Iroquois White Dog Feast, by Rev. W. M. Beauchamp.

Algonkin Onomatology, by A. F. Chamberlain, of University College, Toronto.

Government of the Six Nations, by O-ji-ja-tek-ha.

Results of Explorations about the Serpent Mound of Adams Co., Ohio, for which a grant was made by the Association, by F. W. Putman.

Aboriginal Monuments of North Dakota, by Henry Montgomery.

Steatite Ornaments from the Susquehanna River, by Atreus Wanner.

Notes on the Eskimo of Cape Prince of Wales, Hudson's Strait, by F. F. Payne, of the Observatory, Toronto.

The following is a brief abstract of Sir Daniel Wilson's interesting paper on the Huron-Iroquois—a branch of a subject in which the writer has for many years conducted important and successful researches :—

The Huron-Iroquois of Eastern Canada.—On the occasion of the first meeting of the American Association for the Advancement of Science in the province of Ontario, it was perhaps a matter of interest to the members of the Anthropological Section to have some special notice of the aborigines of this region to the north of the great lakes. Sir David Wilson accordingly noted that the Indians found in this province on its first occupation by English settlers, as well as those now settled on their reserves in Ontario, are nearly all later intruders than the Anglo-Canadian occupants of the soil. On the Grand River the Six Nation Indians have now been settled for upwards of a century, and have made great progress in civilization. They include the Mohawks, Oneidas, Onondagas, Cayugas, Senecas, and Tuscaroras. But they followed the loyalist British colonists, with whom they had taken part in the War of Independence ; and the first of them still preserve the prized heirloom brought with them when they forsook their old native valley of the Mohawk—the silver communion service, inscribed "A.R. 1711. The gift of Her Majesty, Ann, by the Grace of God, of Great Britain, France, and Ireland, and of her plantations in North America, Queen, to Her Indian Chappel of the Mohawks." But though the Six Nation Indians have occupied their reserves on the Grand River for little more than a century, they belong to the great Huron-Iroquois stock, of which Canada is the original home. The speaker accordingly gave a detailed account of the first direct knowledge of the Hurons of the St. Lawrence Valley derived from Jacques Cartier's narrative of his two voyages. He first entered the St. Lawrence in 1535, when he found the palisaded Indian towns of Stadacone and Hoschelaga, on the sites of Quebec and Montreal. We owe to him a vocabulary of their language which proves them to have been Wyandots or Hurons. But when Champlain followed, in 1615, the whole region was a desert. An account was then given of the Huron settlements visited by Champlain on the Georgian Bay, and their extermination by the Iroquois in 1648. Next the traditions of the race were referred to, all in legendary fashion, embodying the myth of their emerging from the heart of a mountain between Quebec and the Great Sea. Their country thus reached, apparently, to the Labrador frontier, contiguous to the Eskimo country. Skulls of the Hurons and Iroquois were produced, including a cast of that of the famous Mohawk chief, Brant ; and attention was drawn to the striking contrast which their predominant dolichocephalic type presented to that of the prevalent American type of skull. In this respect the Huron-Iroquois head-form approximates to that of the Eskimo, and the special aim of the paper was to show the reasons for believing in an admixture at some remote date of this American stock with the Eskimo, who have been invariably recognized by ethnologists as a distinct type from the true Indian of the northern continent.

The Rev. Mr. Beauchamp's contribution on the Iroquois white dog feast had some points of interest. Among the Iroquois, the Senecas and Onondagas alone, the writer showed, seemed to have observed the annual white dog feast, and that only within recent times. It combines some features of both the dream and war feasts, of which it is the successor, and is the beginning of the new year. Penitential exercises take up a portion of the time, with games and various performances of the false faces. His sins confessed and forgiven, his appointed offering made and the fire rekindled on his hearth, the Indian was prepared to enter hopefully on a new year, especially if dreams and games had turned out well. The feast has now lost some of its most striking features, and will very soon altogether pass away.

Section of Geology and Geography.

The Section of Geology and Geography also devoted much of its time to topics of American interest. Mr. Charles White, in his address as Vice-President, touched on "The Mesozoic Division of the Geological Record as it is exhibited on this Continent," referring more particularly to the principal subdivisions of the Mesozoic that have been recognized in North America, their inter-delimitation, their division as a whole from the Carboniferous system beneath and the Cænozoic above. He held that the Mesozoic strata of the Atlantic coast region consist of a probable representation of the Upper Trias of Europe, a possible one of the Upper Jura, a probable slight one of the Middle Cretaceous, but with a hiatus between the latter and the Eocene.

Another paper in this Section, dealing in comparisons of Cis- with Trans-Atlantic formations, was that of Prof. H. S. Williams, of Cornell University, Ithaca. He gave an account of his examination of the English Devonian rocks, under the leadership of Messrs. Ussher and Townshend Hall, during the visit of the International Congress of Geologists in 1888. Comparison of the rocks and fossils with those of Eastern North America led to the conclusions (*a*) that the fossils are very closely allied to the species of the New York Devonian, although in the great majority of cases passing under different names ; and (*b*) that the rocks, in their appearance, composition, and order, are as different as two distinct systems well can be. The great Devon limestone of South Devonshire and Cornwall furnished the fossils upon which Lonsdale based his conclusion that the fauna was intermediate between the fossils of Murchison's Silurian system and those of the Carboniferous limestone, which led to the establishment of a "Devonian" system. When other European localities had furnished more perfect sections of this system, the fauna of this limestone was recognized as the Middle Devonian fauna, and that of Marwood, Pilton, Sloly, &c., as an Upper Devonian fauna. But neither the order of sequence of the rocks nor the separation of the fossils into well-defined faunas can be satisfactorily determined by study of these Devonian rocks alone. Although they have furnished geological nomenclature with a name for the system, they are far from being typical of the Devonian system, as known to most geologists. Comparison of the faunas of the European Devonian faunas with those of the Appalachian basin leads to the hypothesis that the marine life of the two areas had different histories. There is a continuity in the succession from lowest to highest zones of the system in Europe which we do not find in the American series. It is evident that the American Lower and Middle Devonian faunas are more distinct from the corresponding faunas of Europe than are the "cuboides" and later Devonian faunas of the two areas. To account for these facts it is conjectured that a barrier separated the two districts during the lower and middle stages of the Devonian, and that with the "cuboides" stage an incursion of European species began from the European area westward or north-westward, penetrating the Appalachian basin. The mingling of species was not complete, and was stopped altogether by the elevation which terminated the marine Chemung fauna of the New York area. The author also found evidence for the belief that the early Carboniferous faunas advanced northward in the central and Appalachian basins to take the place of the Hamilton and Chemung faunas, which in large measure ceased.

Mr. Frank Leverett, of the U.S. Geological Survey, read a paper on the glacial phenomena of North-Eastern Illinois and Northern Indiana. The paper opens with an explanation of the methods of study already employed, and other methods to be employed in deciphering the history of the drift. A brief discussion is given of the features and phenomena included under the term moraine as restricted in the paper. Among these

features, knobs and basins, swells and says, smooth ridges of till and boulder belts, may be included (though such topography and features are under some conditions non-morainic), but the till plain, "or ground moraine," is not included.

The moraines here discussed are terminal to the *ice* but not to the drift-covered portions of these States. Four evidences of advances in the production of later moraines are cited: (1) buried soils *in situ* between till sheets; (2) changes of direction in flow as shown by striæ; (3) change in form of ice-lobe as indicated by the distribution of the moraine belts and shiftings of the re-entrant and lobate portions; (4) evidence of push or advance in the moraine itself.

The number of distinct moraines varies because of partial coalescence or of local obliteration of portions of certain moraines by later advances. For this reason correlation is difficult. Aside from the difficulty cited there is an increase in the complexity in passing from older to newer moraines. In the older ones the interlobate portions are short, and the moraines can be traced around continuously from one lobe to another through the re-entrant portions. But in newer moraines the terminal loops meet on opposite sides of large interlobate moraines, and correlation is made only after critical study of their connections, over-riding, overwash, &c.

Suggestions are made upon the subject of progressive lobation, but caution is urged against advancing general schemes too early. The study has not been carried far enough to make it possible to draw conclusions of that high order to which future extension of the work will lead.

Before the leading time-intervals in this district can be properly outlined, wider correlations must be made and erosion studies must be carefully prosecuted by competent investigators of erosion phenomena.

Section of Economic Science and Statistics.

Not the least interesting of the papers of this Section was one on "Food Moulds the Race," by Mrs. Nellie S. Kedzie, of the Department of Household Economy and Hygiene in the Kansas State Agricultural College. Mrs. Kedzie traced Irish discontent to the fact that, as she states, whereas "the population of England take on an average 4½lbs. of meat per day," the Irishman eats but 2½ oz. per week. "A hungry man is an angry man," Mrs. Kedzie affirmed, and added, "What wonder that the Irish have grown rebellious, suspicious, and lawless"!

A more serious and important paper in this Section was that of Mr. F. Lester Ward on "The Sociological Position of Protection and Free Trade." The author advocated a protective tariff, and his arguments may be briefly summed up thus:—A protective tariff is a means employed by the State to encourage activities beneficial to that State. The principle is that of inducing certain individuals to put forth energies resulting in benefit to the community at large. Against the argument that public money should not thus be given to private individuals, Mr. Ward urged that the public funds thus spent were analogous to the moneys spent in salaries to Government officials—the end was the same in both cases, viz. the public welfare. A protective tariff tended to make the State self-sustaining. The statesman is not a humanitarian; his duty is the weal of his own country. He is justified, therefore, in advocating measures of self-defence. But as with individuals, so with States: those acts which are performed for the object of self-defence conduce to the welfare of the collective whole. There is no such thing as free competition. The term itself implies friction. It requires intelligent interference to preserve competition free. Competition left to itself promotes monopolies. The protective tariff prohibits the unnecessary transportation of commodities. This results in economy.

But the paper that attracted the largest amount of attention in this Section was that of Mr. B. E. Fernow, chief of the Forestry Division of the Department of Agriculture of the United States. A graduate of a Forestry Academy of his own country, Germany, where, as he himself said, the preservation of forests is traditional, Mr. Fernow is astonished at the careless—in many cases, indeed, deliberate—wastefulness with which the New World utilizes its treasures of timber, and he looks to the Government to remedy the evil. "As far as the forest yields material for the arts," he said, "it is an object of private industry; but when, by its position on a watershed, the forest becomes an influential factor in the water conditions of the plain, it may still serve the purposes of gain and wealth, which are the objects of private industry, but its indirect significance for society at large exceeds the private interest, and this class of resources, being in the direction of a social gain or gain for a larger number, must become an object of public economy by the State or community."

The following passage from Mr. Fernow's paper is worthy of quotation, showing as it does his perspicacious views on this difficult problem of forest conservation:—

"Whatever tends to stimulate private activity is to be promoted. Whatever retards development of intensive methods is to be removed by Government. Industrial education, cultural surveys, organization of national irrigation systems, fish commissions, bureaus of information, experimental stations and other aids to private enterprise will constitute the chief methods of expressing State interest with regard to these resources. The three great sources upon which mankind is most dependent, which demand first the attention of the State, are the soil, as food producer, the water, and climatic conditions. A rational management of the water capital of the world in connection with the agricultural use of the soil will become the economic problem of the highest importance, as the necessity for increased food production calls for intensive methods. In the United States the action of the Government on economic and cultural questions is apt to be fitful and the result of personal influence rather than a logical analysis of conditions and principles. While our Government is ready to go to war in order to protect its fisheries, it has never even known the value as food supply of the game which has been killed. Whole races of animals have been extirpated before there were population enough to require the meat. While with one hand we pay exorbitant prices in land and wasted energy to get the plains re-forested, and that with poor success, with the other hand we offer a premium for forest destruction in mountains by leaving them without proper administration. And now we propose to establish irrigation systems, neglecting to provide first for those conditions which assure a regulated water supply—namely, by forest preservation."

This paper led to the adoption by the Association of three resolutions: one, that Congress be memorialized on behalf of a proper administration of the forests of the western mountain ranges; a second, that legislative enactments were necessary for the development of natural resources; and a third, appointing a committee to urge the importance of these matters on the President and Congress of the United States and on the Premier and Parliament of Canada.

Section of Chemistry.

The Vice-Presidential address in this Section was read by Prof. William L. Dudley, of Vanderbilt University, who gave a *résumé* of the more important researches on the nature of amalgams, to which was appended a very complete index to the literature on the subject. Prof. Dudley confined himself almost wholly to the historic aspect of his theme, taking occasion only to remark that the results of previous experiments seem to prove that amalgams are chemical compounds more or less unstable.

Mr. Charles Munro spoke on the explosiveness of the celluloids. He gave the results of experiments for testing their stability, flashing-point, &c., and maintained that the opaque varieties were insensitive to detonation at ordinary temperatures, but that the translucent readily exploded.

Mr. John W. Langley, of Pittsburg, read a paper on "International Standards for the Analysis of Iron and Steel." He stated that a system of international standards had been arranged for between England, France, Germany, Sweden, and the United States. He gave a description of the system, and asked the Section to name one chemist to act with six others to conduct the analysis on behalf of the American Committee on the International Standards, and to co-operate regarding the same with European analysts. The meeting appointed Mr. Thomas M. Brown, of Boston, with Prof. F. A. Gooch, of Yale College, New Haven, Conn., as alternative.

Section of Mathematics and Astronomy.

In the Section of Mathematics a paper—which resulted in an important resolution being adopted by the Association at large—was read on the Peruvian arc. The two meridional arcs, the one in Peru and the other in Lapland, measured a century and a half ago, were examined by Mr. E. D. Preston, of the United States Coast and Geodetic Survey, with reference to the degree of accuracy attained, and a comparison was made between the

uncertainties of these measures and those resulting from work with modern instruments, and following more recent methods. It was shown that the probable errors were much larger than would be indicated by the agreement of the published results, and that therefore the concordance of this arc with those in other parts of the world is no proof of its accuracy. By far the most significant errors came from the astronomical observations, and the unavoidable uncertainties here, either from the imperfection of the instruments, or the attraction of the high mountains, were shown to affect perceptibly the present value of the earth's axis.

The resolution touching this matter, which was unanimously adopted at a general session of the Association, reads as follows:—

"Whereas the history of geodesy includes no more important page than that relating to the measurement in 1739 of the so-called Peruvian arc, which work was conducted by the French Government with the co-operation of Spanish officers, and in magnitude of plan and difficulty of a most serious character it was in its time unexcelled; whereas recent improvements in all the processes incidental to such an undertaking have been so very great, rendering possible a vastly more accurate execution of the work; whereas it is and has been for several years a matter of deep regret that the one great contribution which the American continent has made to the solution of the problem of the figure of the earth should fall so short of what it should and might: be it therefore resolved by the American Association for the Advancement of Science, that the Congress of the Three Americas about to assemble in Washington is earnestly requested to consider the desirability of undertaking the measurement of this Peruvian arc, to be accomplished by a union of the Republics represented. This result is not likely to be reached except through international effort, and this recommendation by the Congress would be a fitting and proper act of this first conference of representatives of the New World."

Section of Physics.

The President of the Association, Mr. T. C. Mendenhall, read before the members of this Section a short paper on globular lightning. He adduced no new theory as to its source or character, but submitted an interesting account of several authentic records of its occurrence, many of them abstracted from the reports sent in to the United States Hydrographic Office. He showed that there was abundant trustworthy proof that atmospheric electricity took on the form of globular lightning, but conceded that the evidence was in details discordant. He hoped that some day opportunity might be given to obtain a photograph of the phenomenon.

Mr. Thomas Gray read a paper on the relative values of the magnetic and the electrodynamic methods of measuring electric currents in absolute measures.

In the subsequent discussion on the paper, Prof. Nichols, of Cornell University, stated that he had compared the constants of one of Sir William Thomson's balances as certified by him, with the constants as determined by the large standard galvanometer in Cornell University, and found them to agree perfectly through the entire range—a result with which he was greatly pleased.

Prof. H. S. Carhart, of the University of Michigan, read two papers before this Section, one on magnetic leakage in dynamos, the other on an improved standard cell with low temperature coefficient. The following abstracts of these papers will show their gist and purport:—

The first paper gives an account of some experiments to determine the magnetic leakage of two dynamos of the Mather and Edison type respectively; the former was a small machine of 500 watts capacity, built by a student in the laboratory, the latter an Edison of 5000 watts capacity.

In the small machine the leakage was due to some projecting machine steel studs which carried the armature yokes. The number of magnetic lines cut by the armature when the machine was coupled as a self-exciting shunt dynamo was determined, and then the steel studs were replaced by brass and the determinations were repeated. The result was 190,000 and 252,000 lines of force respectively, or a gain due to removing the steel studs of 32·6 per cent. This was partly due, however, to increase in the field when the leakage was stopped. Hence the machine was independently excited by a storage battery, and the number of lines determined in the two cases as before. The result was 164,600 and 184,100 lines cut by the armature with and without steel studs, a gain of 11·2 per cent. This measured the true leakage due to the assigned cause.

The leakage in the Edison machine was due to the iron bedplate. A plank base was made, and the number of magnetic lines cut by the armature was determined first with the iron base and then with the plank, the machine being self-exciting and running at the same speed in the two cases. The number of lines was 1,510,000 and 1,605,000, a gain of 6·25 per cent. due to removal of the cause of leakage.

In his second paper, on an improved Clark standard cell with low temperature coefficient, Prof. H. S. Carhart said:—"The objections to the Clark cell, as described by Lord Rayleigh, are high and variable temperature coefficient, objectionable mechanical construction, and serious local chemical action. These I have, at least in large measure, overcome. The cell which I now make is so constructed that the mercury cannot reach the zinc during transportation. The temperature coefficient is represented by the equation

$$E^t - E[1 - \cdot000387(t - 15) + \cdot0000005(t - 15)^2].$$

Per degree the coefficient is

$$- \cdot000386 + \cdot000001(t - 15).$$

At 0° C. this coefficient becomes $- \cdot000401$; at 25°, $- \cdot000376$; and at the highest temperature observed, 52°·7, it is $- \cdot000348$. It will be observed that this coefficient diminishes with rise of temperature, while that of Lord Rayleigh's cells increases. In cells of the old form local action is due to zinc replacing mercury when in contact with the solid mercury salt. The zinc is thus amalgamated, and the amalgam creeps up. This I prevent by keeping the zinc out of contact with the mercury salt. The same device has the effect of raising the E.M.F. about 0·4 per cent. The polarization of these cells amounts to only one ten-thousandth part in five minutes with an external resistance of 10,000 ohms. It recovers in a few minutes. The different cells show great uniformity of E.M.F. All comparisons are made by Lord Rayleigh's method slightly modified. A change or difference of E.M.F. of one ten-thousandth part is very readily detected."

In this Section Messrs. W. A. Rogers and R. T. Woodward, in a paper on mercurial thermometers, held the following theses:—(1) The movements of a mercurial column are in all cases by pulsation; (2) these pulsations have a regular recurrence; (3) the period of recurrence is constant in the same thermometer; (4) every pulsation has the same harmonic relation; (5) the amplitude of the curve which represents the harmonic is inconstant; (6) as the period is constant and the time required for the completion of the cycle variable, it follows that the danger of error in random readings of the thermometer is greater for slow than for rapid variations of temperature.

Section of Biology.

In the Biological Section, Mr. A. J. Cook read an interesting paper on the alimentary apparatus of the bee, in which he embodied the results of a long series of personally conducted experiments. He differed, he said, widely in many particulars from the author of the article on the anatomy of the bee in the "Encyclopædia Britannica," notably as regards the conformation of the tongue. This organ, Mr. Cook strongly maintained, was a hollow cylinder furnished on the under side with a slit throughout its entire length. He explained that suction could be performed in three ways: (1) through the terminal aperture of the internal tube, when the nectar could be reached only by the end of the tongue; (2) through the slit opening into this tube, when the fluid to be sucked in was shallow and placed on a flat surface; (3) by the aid of the labial *palpæ* when the fluid was abundant. The author also expressed his incredulity as to the possibility of a trustworthy analysis of honey, arguing that in many cases more nectar was taken into the honey-stomach by the bee than the glands had time or secretion sufficient to digest. Especially, he thought, did this happen when the linden was in bloom, when a single hive of bees would sometimes store up 15 pounds of honey in the day. The queen bees and the drones, he held, were fed with digested food only, and to this fact he traced the extraordinary fecundity of the queen bee.

Prof. Burrill read a paper on fermentation of ensilage. He stated that all fermentation of organic matter is now universally admitted to be due to the action of micro-organisms, and he described the phenomena presented in recently stored green fodder, used for cattle food. This material is now placed in

bins of large size, where it soon becomes very hot, reaching a temperature of 60° C. (140° F.). This temperature was sufficiently high to kill or at least prevent the growth of nearly all animal and vegetable species, 50° C. being the upper limit. Upon the proper examination of this hot material one soon finds that a single species of Bacteria (*Bacillus butyricum*) is associated with the fermentation and subsequent rise in temperature. Further tests prove that it is the cause of these changes. Secondary changes are very liable to occur as the heat decreases, and lactic and acetic acid, the latter often in large amounts, are produced. Possibly alcohol is sometimes, but never as a first product of the hot material.

On the whole, this the thirty-eighth annual meeting of the American Association for the Advancement of Science may be considered to have been a successful one. Close upon two hundred papers were actually read in the various Sections, some of these of course not reflecting that "dry light" which is supposed to beat upon all scientific investigation, yet the majority of them evincing real and enthusiastic work on proper lines. One thing, however, might have been noticeable to an English ear, many of the writers seemed to possess a greater mastery over abstruseness of subject than over elegance of diction.

Many eminent men, some famous in both hemispheres, were present. The total number of persons in attendance on the meetings, and actually belonging to the Association, either as Fellows, Members, or Associates, was between four and five hundred.

Financially, the Association is declared to be in a better position to-day than ever it has been before. The annual income is at present about $6000. It has also the sum of $4500 invested at 5 per cent., the interest of which is devoted to the furtherance of original research. For the ensuing year this sum has been apportioned thus: $150 to Prof. Moseley to continue his researches on the velocity of light in the magnetic field; and $50 to Prof. Attwater for the purpose of investigating the heats of combustion of certain mineral and vegetable compounds.

Indianapolis and the third Wednesday in August were chosen as the place and time of meeting for 1890. Mr. G. L. Goodale, of Cambridge, Massachusetts, was elected President for the coming year.

The meeting was closed by a public gathering, at which many complimentary speeches were made both by hosts and guests.

ARNOLD HAULTAIN.

THE IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute was held last week in Paris under the presidency of Sir James Kitson. The meeting was held in the rooms of the Société d'Encouragement, and was addressed, in the first instance, by M. Eiffel, President of the Société des Ingénieurs Civils, and by M. H. de la Goupillière, President of the Société d'Encouragement. The President of the Institute, after thanking M. Eiffel and M. de la Goupillière for their kind hospitality, announced that the Council had awarded the Bessemer Medal to M. Henri Schneider, of Creusot, for his services to the iron and steel trade of France, to whom it was presented on Friday by Sir Lowthian Bell. Sir James Kitson made a brief address, referring to their last visit to Paris in 1878, under the distinguished presidency of the late Sir William Siemens, to the increase in the roll register of the Institute which had taken place since that date. He drew attention to the improvements which had taken place during the last decade in the metallurgy of steel and iron; the commercial development of the Siemens-Martin and Thomas-Gilchrist steel processes; the increased development in the manufacture of steel owing to the extension which had taken place in its applications. The Eiffel Tower was an elegant example of the scientific power and imaginative genius of French engineering, whilst the French chemical study of the processes of metallurgy had rendered great service, not only to their own industry, but to that of the world at large. The names of many eminent French metallurgists were mentioned, and the work they had done was briefly referred to.

The business of the meeting was then proceeded with, viz. the reading and discussion of the various papers which are referred to below.

Prof. S. Jordan's paper, "Notes on Iron and Steel Manufacture in France in 1887, and as illustrated by the French exhibits at Paris," the first paper read, was of a statistical character, and compared the present production of these metals with what it was ten years ago.

The Channel Bridge.—This was a paper by Messrs. Schneider and Co., of Creusot, and M. H. Hersent, Past-President of the Société des Ingénieurs Civils, descriptive of a bridge for connecting England with the Continent. The paper consists of three parts, an introductory notice, a general description of the bridge, and of the superstructure, being preliminary projects of M. Hersent and Messrs. Schneider respectively. From the introductory notice it would appear that projects have been submitted by Messrs. Fowler and Baker, but these are not published in the paper.

It is proposed that the bridge should span the Channel at about its narrowest portion—namely, between Folkestone and Cape Griznez, a distance of 25 miles, by which means also the sand-banks of Varne and Colbart can be taken advantage of, thereby diminishing the height of the piers necessary to be erected. These banks are in mid-Channel, about 3¾ miles apart, and are separated by a depression of between 80 and 90 feet deep; this is also about the depth between the bank and the British coast, whilst on the French side, between the Colbart Bank and the Cran-aux-Œufs, the bottom sinks somewhat abruptly down to 132 feet, attaining 180 feet about midway across, when it gradually rises again. In these parts the chief difficulties would be encountered in laying the foundations. As the result of frequent experiments, it is found that the blue and white chalk which forms the Channel bottom is capable of supporting a load of from 140 to 170 pounds to the square inch, and the surface of the bases of the piers has been so calculated that the foundations should not have a greater load on them than the smaller of these amounts. This would imply that no factor of safety has been allowed, which is hardly likely to be the case, as in masonry structures with a live load a factor of safety of 8 is generally recommended; on the other hand, the ordinary kinds of chalk are capable of resisting a crushing pressure of 330 pounds per square inch. The masonry piers are 190 feet in length at the base, and 140 feet above, the width depending on the columns which they have to support. The distance between the piers is fixed at 1650 and 990 feet, 1155 and 660 feet, and 825 and 330 feet, the largest spans corresponding to the greatest depths, and the smaller ones to smaller depths and the parts near the shore. Each supporting pier will consist of a block of masonry of best material, set with Portland cement, and laid on the sea bottom; the masonry will be built inside metal caissons similar to those used for ordinary bridge piers, and forced by compressed air down to the solid ground. Their surface above high-water level will form the foundation for the metal columns, which are cylindrical in shape, and vary in height between 132 and 140 feet, and on them are placed the main girders of the bridge. These girders are 200 feet above low-, and 178 feet above high-water level. This height is amply sufficient for the passage of the largest ships. The system of girders proposed to be employed is simple, unlatticed, trussed, so as to insure the proper distribution of all the stresses. After consideration it has been found advisable, instead of forming the 990 and 1650 feet spans of girders extending over the whole length of 990 feet, and extending on either side in the form of cantilevers of 825 feet, so that the junction of the two cantilevers should constitute a span of 1650 feet in all, not completely to cover the spans by means of cantilevers, but to connect these by an ordinary independent span, a saving of 17 per cent. being thus realized in each overhanging portion of the cantilever. In this manner the 1650-feet span comprises two cantilevers of 619 feet each, and an independent span of 412 feet. The metal flooring on the central span and cantilever is formed of two girders resting upon two piers 990 feet apart, and lengthened on either side to the extent of 619 feet. These girders are 36 feet high at the ends of the overhanging portions, and 214 feet high almost throughout the span of 990 feet. Each girder consists of two chords connected by bracings forming isosceles triangles. The lower ribs of the two girders have a distance of 82 feet between their axes in the central span of 990 feet, and an interval of 33 feet at the ends. The level of the permanent way is 237 feet above low water; a double set of rails is proposed, and the width of flooring proper will be 26 feet.

The paper further gives a detailed description of the foundation work, comprising the situation and dimensions of the piers, the construction, conveyance, and fitting into position of the supporting columns, and the materials and machinery required for the completion of the work; also the construction, transport, and putting

into position of the metal spans, with estimates of weight, and calculations of the resistances throughout the structure. The metal required for this bridge would amount to a million tons, of which about three-quarters would be steel; the cost is estimated at £35,000,000, and the period requisite to complete the work ten years. This interesting pamphlet of nearly 100 pages will be referred to on account of the careful manner in which the subject has been brought forward, even should the building of the bridge not take place, on account either of political objections or constructive difficulties. As stated in the paper itself, each pier comprises a small lighthouse, and as about 150 of these small lighthouses will have to be erected, an injury to any one of which would close the bridge for a lengthy period, one thinks of the Eddystone Lighthouse, built by Smeaton 100 years ago, which has had to be replaced, not on account of any fault in its design or construction, but because the sea had made inroads on its foundation of rock.

On Gaseous Fuel, by Sir Lowthian Bell. The author assumes a certain quality of coal, and then compares the work that can be performed with it according as it is used in the solid state or in the condition of producer gas or in that of water gas. Producer gas is that supplied to the Siemens regenerative gas furnace; the specimen of coal used for comparison is assumed to consist of 70 per cent. fixed carbon, 16 coal gas, and 14 ash, oxygen and nitrogen, and the producer gas obtained from it of 16 parts of coal gas, 163·3 of carbonic oxide, and 222 of nitrogen, the producer gas being supplied cold at the foot of the regenerators; the calorific value of the coal is 7200 calories. 100 parts of this coal are equal to 720,000 calories, and by the combustion of the producer gas 551,920 calories are produced, showing a loss of 168,080, equal to 23·3 per cent. The method of manufacture of water gas is next explained. The fuel recommended to be employed is coke, which is placed in a cylinder of iron lined with fire-brick; the coke is rendered incandescent by an air blast. When in this state the blast is stopped, and a jet of steam passed through it. The steam is decomposed; its oxygen burns the carbon into carbonic oxide, setting free the hydrogen, the mixture constituting so-called water gas, comprising equal volumes of carbonic oxide and hydrogen. The change in producing water gas is expressed chemically by $H_2O + C = H_2 + CO$, and the heat required to tear hydrogen away from its associated oxygen is not less than that evolved when the two gases unite, or $2 \times 34,200 = 68,400$ calories. The weight of the combining equivalent of carbon required to effect the change is twelve times that of the two units of hydrogen, and the heat generated by this quantity of carbon being burnt to carbonic oxide is $12 \times 2400 = 28,800$, so that something over $14\frac{1}{2}$ units weight of carbon will be required to generate a unit weight of hydrogen. But as only 6 units of carbon are being burnt per unit of hydrogen, the incandescent carbon is soon cooled down below the temperature of decomposition. When this point is arrived at, the steam is shut off, and the blast is again turned on. Using the data given in the water gas publications, water gas produces per 100 parts of carbon 682,520 calories out of a possible total of 800,000, there being a loss of 14·68 per cent.; as the coke used is produced from coal, the actual loss rises to 37 per cent. The author sums up as follows:—

(1) Coal as burnt in an ordinary furnace—

	Calories.
100 parts, yielding 7200 calories per unit	= 720,000
Chimney gases, estimated after making the necessary allowance for oxygen in the coals, 1129 units × 427° C. × ·24 specific heat	= 115,700

the loss in this case by chimney gases being equal to 16·07 per cent.

(2) Producer gas from same coal, as used in the Siemens furnaces, without the addition of steam—

	Calories.
70 of carbon or 133·33 of CO × 2400	= 391,992
16 of coal gas × 10,000	= 160,000
Sensible heat transmitted to furnace	62,411
	614,403
Heat in chimney gases, 1129 × 377° C. × ·24 specific heat	= 102,151

Loss of chimney equal to 16·61 per cent.

(3) Water gas and its accompanying producer gas—

	Calories.
Water gas, 17°·5 C. = 40·83 CO × 2400	= 97,992
Hydrogen from steam, 2·926 × 29,400	= 86,024
	184,016
Producer gas, 52°·5 C. = 122·5 CO × 2400	= 294,000
Coal gas, 16 × 10,000	= 160,000
Sum of heating-power of water gas and producer gas...	638,016

Heat in a chimney gas assumed at same temperature as ordinary producer gas—

779·7 × 377° × ·24 sp. heat = 70,547 calories = 11·05 per cent.

These figures intimate that each 100 units of the three kinds of fuel burnt there is afforded by: coal, 83·93; producer gas, 71·14; water gas and its producer gas, 78·80.

To these figures of Sir Lowthian Bell the supporters of gaseous fuel will object that, if with the use of gaseous fuel there are 1129 units of waste gases passing up the chimney, with solid fuel there must be considerably more; whilst the employers of the regenerative gas-furnace, whilst accepting 377° C. as the temperature of their chimneys, will not allow the same for water gas, where regenerators are not used.

Another interesting paper presented to the meeting was one by Mr. W. C. Fish, on the Thomson electric welding process. The *rationale* of the process may be thus shortly described. If an inclosed circuit of inappreciable resistance be completed by the insertion and abutment of short lengths of the pieces to be welded, the passage of an electric current through the circuit will produce a transformation of electric into heat energy, and the production of this heat will take place almost entirely at the point of abutment of the metal pieces where the cross-section of the conductor is virtually of least area, and the resistance is proportionately great. If the current is of sufficient strength, a welding heat is produced at the point of abutment, and, with the aid of suitable pressure forcing together the heated extremities of the pieces, a weld is made. Various applications are given in the paper, the employment of an alternating current dynamo and a transformer being found the most effective method of working.

Mr. Alexander Siemens, in the discussion of this paper, said he was able to confirm the general results given, for in making one of the Atlantic cables twelve years ago, it was found that welding could be done more quickly by electricity than by ordinary means. An electrical machine was placed alongside of the cable machine, and they made all the joints for the sheathing of the wire by electricity. They would find that the subject had been mentioned by Sir William Siemens in his address to the Mechanical Section of the British Association at Newcastle in 1877.

Papers were also presented to the meeting on the Robert-Bessemer steel process, by Mr. F. L. Garrison, of Philadelphia; on alloys of iron and silicon, by Mr. R. A. Hadfield, of Sheffield, both being papers of a technical character. A new form of Siemens furnace, arranged to recover waste gases as well as waste heat, was described by Mr. John Head, and M. P. Pouff, of Nevers. In this furnace, instead of two air and two gas regenerators being employed, only a pair of air regenerators are used, the gas being supplied hot to the furnace. Instead of the whole of the products of combustion being passed through the regenerators, a portion is directed through a regenerator to the chimney, and the remainder through a converter producer, there to be reconverted into combustible gases, and to do the work of distilling hydrocarbons from the coal; in fact, the gas producer or converter in this furnace absorbs or utilizes the heat formerly deposited in the gas regenerators, and in doing this transforms spent gases into combustible gases. It had to be ascertained whether the products of combustion from the heating chamber would contain a sufficient amount of heat to insure their conversion into combustible gases; this has been found to be the case in practice with furnaces working for the past six months. Assuming that the producer contains only coke in the incandescent state, this coke if fed with oxygen will produce carbonic acid in the lower, and will be converted into carbonic oxide in the upper zone of the producer; if fed with hot carbonic acid instead of oxygen, one-half the fuel, comprising the lower zone, may be dispensed with, and an economy in weight of fuel to the same extent realized. In actual practice finished rolled iron has been heated in this furnace with a consumption of fuel as low as 2 cwt. per ton of iron.

SCIENTIFIC SERIALS.

American Journal of Science, September.—From experiments here described, Messrs. A. A. Michelson and E. W. Morley infer the possibility of establishing a material standard a metre long, whose length in light-waves is known to within one part in one million, and perhaps one in ten millions.—Mr. H. Crew has measured spectroscopically the solar rotation for a zone some 60° wider than any before observed, getting the equatorial value 26·23 days, and finding no certain variation of period with latitude by this method. A comparison of the results from various methods appears to suggest a decrease of angular velocity outwards.—Stretching suddenly soft annealed wires by descent of weights through a trap door, and measuring thermo-electrically the heat evolved, Mr. C. Barus finds that as much as one-half the work done in stretching up to the limit of rupture may be stored up permanently. The work thermally dissipated varies (*e.g.* 75 per cent. for copper, 60 for brass, and 50 for iron); and with a given metal, there is large potentializing in the first stages of strain, and large dissipation in the final stages.—Mr. J. Trowbridge shows reason for thinking that short waves of electrical energy are not absorbed by an approximately perfect dielectric.—A determination of the value of the B.A. unit of resistance in absolute measure by the method of Lorenz, by Messrs. Dancan, Wilkes, and Hutchinson, yields the value 0·9863 ohms.—The Carboniferous Echinodermata of the Mississippi basin are studied by Mr. C. R. Keyes. Crinoidea greatly predominated in the first part, and Blastoidea in the later part, of the period. Abrupt differentiation and extinction of genera towards the end of the Keokuk formation, point to decided changes in the environment.—Mr. M. Carey Lea continues his interesting account of the properties of allotropic silver. No other metal seems capable of such a variety of appearances. *Inter alia*, he notes the remarkable beauty of colouring in rings produced by a small crystal of iodine placed on paper that has been coated with allotropic silver in its moist and plastic state.—There are also papers on the "Grand Gulf" formation of the United States (Mr. L. C. Johnson); paragenesis of allanite and epidote as rock-forming minerals (Mr. W. H. Hobbs); a fossil spider (Mr. C. E. Beecher), &c.

Revue d'Anthropologie, troisième série, tome iv., quatrième fasc. (Paris, 1889).—Scientific anthropometry and artistic proportions, by Colonel Duhousset. In treating of the origin of anthropometric canons of proportion, the writer considers that while there is no doubt of the influence exerted by the Egyptians on Hellenic art, the beauty of their own people must early have led Greek artists to adopt, as typical models for the representations of their divinities, the most highly developed specimens of the human form, as it was manifested in their immediate neighbourhood. It would appear that the most ancient canon of beauty recognized by the Greeks was derived from Polycletus (452-412 B.C.), whose celebrated statue, "Doryphorus," the spear-bearer, was long known as "canon" from its perfect embodiment of the ideal of the male figure. A century later this type gave place to the more idealized representation of Lysippus, who in his statues of the gods raised the height of his figures from the ordinary proportion of 7½ to 8 heads. Under Vitruvius the proportions of Lysippus received greater precision, and became the type that has essentially served through later ages as the true canon for the perfect human form. The purpose of the writer is to compare this artistic type with a scientific canon, for the establishment of which our recent progress in anthropology now for the first time supplies the necessary materials.—In a subsequent article, M. Topinard, following up the relations between these two canons of proportion, treats of the differences between the methods followed by the artist and the anthropologist. He considers that the establishment of a scientific canon demands a careful study of the skeleton and the body immediately after death, as well as of the living subject, and his observations, elucidated by numerous tables, will be found of great value to the artist. He suggests, *e.g.*, that the decimal system of measurement should be used in determining the proportions of the several parts of the body to the whole body, while racial and sexual differences should be taken into account before the height of the figure is determined. This preliminary step is of importance, for while all races have a general similarity in the proportion of the height of the head to the whole body, the yellow races have comparatively "high" heads. Women, moreover, in all races, other things being equal, have higher heads than men. M. Topinard concludes that there is no fixed relation between variations in the height of the head and those of other parts of the body, and that, consequently, the artistic method of taking the head as a standard for the relative proportions of the rest of the body is erroneous. Hence there is no absolute type of beauty, the canons of proportion varying with sex, age, race, and individuals.—On vestiges of pagan practices among the Provençals of our own days, by Dr. B. Férand. The Provençals, who from their origin were powerfully influenced by the Greeks and Romans, still retain in their modes of worship, and their social and domestic habits, numerous traces of paganism. Curious instances of this are supplied by the practice of libations, still followed by the peasants of Provence, who, after having concluded some unusual transaction, or an agreement of importance, commemorate the event by pledging those present, after which they invariably extend the right arm and turn their glass down, so as to let the last drop fall to the ground. Similarly, at the festival of Christmas, which is locally known as "Leis Festos de Caleno" (the Calends), a solemn repast is partaken of, known as "Lou gros Soupar," at which the eldest and the youngest member of the assembled family perform, amid a profound silence, the ceremony known as the "benediction of the fire." This act is performed by pouring wine three times upon the burning log, which must be of oak or olive wood. This is accompanied by the singing of some verses, in which the excellence of fire is praised, and God is thanked for having given man beneficent heat. These verses vary in different localities, but everywhere the ceremony of the silent libations precedes the supper of which the combined household partake.—On lacustrine and other pile-structures in Northern Italy, by M. P. Castelfranco. The writer gives an interesting summary of the various works which have appeared in Italy in recent years, regarding the different forms of pile-structures discovered in the Parmese and neighbouring lowlands. In Italy such explorations date back only to 1861, when MM. Pigorini and Strobel discovered extensive remains of prehistoric pile-dwellings at Castione. Since then other explorers, more especially Dr. Chierici, have followed up these researches in the province of Reggio, where the latter discovered traces of a *chaussée* raised above the level of the ground on closely adjusted piles. The remains of some of the pile-dwellings showed, moreover, that there had been in course of time as many as three distinct structures raised the one upon the substructures of the others. The animal remains and the flint implements found in the *débris* belonged to the Bronze Age. M. Castelfranco's summary is worthy of the careful attention of our most distinguished palæontologists, while the important facts which he adduces appear to warrant the interesting conclusion that in these palustrine habitations of Northern Italy we have the most ancient Italian stations of the tribes, from whom descended those prehistoric peoples whose occupation of the country is attested by the celebrated cemeteries at Villanova, Bologna, &c., which belong to the earliest period of the Iron Age. M. Pigorini believes that the civilization of the palustrine and land-pile dwellings—the *terremare* of Northern Italy—is identical with that of prehistoric Hungary, which gradually penetrated to Central Europe by the Danube and its great affluents, the Drave and the Save, but never advanced to the western districts of France, or to Britain, where there is no trace of any but lacustrine pile habitations.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, September 4.—Captain H. J. Elwes, Vice-President, in the chair.—Prof. C. H. Fernald and Mr. C. J. Fryer were elected Fellows; and Prof. C. V. Riley and Dr. A. S. Packard were admitted into the Society.—Mr. G. T. Baker exhibited two remarkably dark specimens of *Acronycta ligustri* taken near Llangollen.—Dr. P. B. Mason exhibited and remarked on a collection of Lepidoptera which he had recently made in Iceland. The following species, amongst others, were represented, viz.:—*Crymodes exulis*, *Triphæna pronuba*, *Noctua conflua*, *Plusia gamma*, *Larentia cæsiata*, *Eupithecia scoriata*, *Melanippe sociata*, *Coremia munitata*, *Phycis fusca*, and *Crambus pascuellus*.—The Rev. Dr. Walker also exhibited a number of Lepidoptera, Diptera, and Hymenoptera, recently collected by himself in Iceland.—Mr. W. White exhibited, on behalf of Mr. G. C. Griffiths, a specimen of *Nephronia hippia*, Fab., var. *gæa*,

Feld., which he believed to be hermaphrodite. He also exhibited, for comparison, a female of the same species. A discussion on hermaphroditism ensued, in which Mr. Distant, Captain Elwes, Mr. McLachlan, and Mr. Baker took part.—Dr. Sharp exhibited specimens of *Cychramus luteus* and *fungicola*, Auct., and stated that they are the sexes of one species, *C. luteus* being the male, *C. fungicola* the female. In working through the Central American *Cychramini*, he had found that in some genera the males differed greatly from the females in size and sculpture; but this was not a constant character, for in some species, while certain males scarcely differed from the females in these respects, others were so different that they would scarcely be recognized as belonging to the same species.—Mr. E. A. Butler exhibited specimens of *Platymetopius undatus*, from Ewhurst, Surrey. He remarked that the species was recorded as having been once previously taken near Plymouth by the late Mr. J. Scott.—Mr. G. T. Baker read a paper entitled "On the distribution of the Charlonia group of the genus *Anthocharis*." Mr. Baker stated that the species of this small division of the genus Anthocharis formed a very natural and closely allied group, presenting many points of interest, both in their relationship to each other, and in their geographical distribution, which extended from the Canaries on the west to the valley of the Indus on the east. The author's theories as to the causes of the present distribution of the group, which were based on geological data, were discussed by Captain Elwes, Mr. McLachlan, Mr. Distant, and Mr. Stainton.—The Chairman read a paper entitled "On the genus *Argynnis*," which gave rise to a discussion in which Mr. Distant, Mr. Jenner-Weir, and Prof. Riley took part.

SYDNEY.

Royal Society of New South Wales, August 7.—Sir Alfred Roberts, Vice-President, in the chair.—The Chairman announced that the Council had awarded the Society's bronze medal and a money prize of £25 to the Rev. John Mathew, Coburg, Victoria, for his paper upon the aborigines of Australia: also that the Clarke Memorial Lectures would be delivered to the members of the Society by Mr. C. S. Wilkinson, Government Geologist, as follows: (1) on the geological researches of the late Rev. W. B. Clarke, F.R.S., S. Stutchbury, and other early Australian geologists, November 13; (2) on the geology and ancient life-history of Australia, November 20; (3) on the economic geology of Australia, November 27.—The following papers were read:—On the source of the underground water in the western districts, by H. C. Russell, F.R.S.; on the eruptive rocks of New Zealand, by Capt. F. W. Hutton; on the application of prismatic lenses for making normal-sight magnifying spectacles, by Mr. P. J. Edmunds; flying-machine memoranda, by Lawrence Hargrave.

PARIS.

Academy of Sciences, September 23.—M. Des Cloizeaux, President, in the chair.—International Congress of Chronometry; International Congress of Applied Mechanics, by Mr. Phillips. The former, at his instance, expressed the desirability of thorough experiments, at Government expense, to determine how compensation is affected by the nature of metals and alloys used for springs and balance wheels, and the various types of the latter. The other Congress expressed a similar wish for the formation of testing laboratories for materials and machines, and for an International Commission to fix units and uniformize methods; it also proposed definitions of the terms used in mechanics. M. Mascart called attention to the fact, that, while the proposed unit of power, the *poncelet*, was 100 kgm. per second, the electricians' *kilowatt* was 102 kgm. per second. M. Berthelot objected to proper names being used for abstract units.—On analysis of the light diffused by the sky, by M. Crova. He made observations on the top of Mont Ventoux, with a modified form of his spectro-photometer, which could be directed to any part of the sky. The curves for zenithal light (alone examined) show a predominance of the more refrangible radiations at sunrise, diminishing towards midday, then increasing towards sunset; but not reaching, in homologous hours after noon, the same values as in the morning. The curves vary notably from day to day, with the state of the atmosphere. His figures show to what extent the light is bluer than the direct sunlight, and the light of the sky at Montpellier.—The Emperor of Brazil announced, by telegram, an observation of globular lightning on September 16.—Observations of Davidson's comet, with the bent equatorial (0·35 m.) of Lyons Observatory, by M. Le Cadet.—Observations of Brooks's comet and its companion, by the same. The nebulosity of the companion was elongated in the line of junction, and, at times, seemed to join the other.—On the determination of integrals of certain equations with partial derivatives by their values on a contour, by M. E. Picard.—Physiological researches on hydrocyanic acid, by M. N. Gréhant. Diminishing the force of the poison by dilution, &c., he found (in dogs and frogs), the heart-beats persist after the respiratory movements (gradually) stopped.—On the phosphorescent infection of *Talitrus* and other Crustacea, by M. A. Giard. On examining microscopically a brightly phosphorescent *Talitrus* he found walking slowly on the beach (instead of leaping like its companions), he traced the light to bacteria in its muscles, which were greatly altered. He inoculated other individuals (both *Talitrus* and *Orchestia*) with blood containing these microbes, and produced the disease with entire success. The laboratory cellar had quite a "fairy-like" aspect in the evening. The inoculations were continued to the sixth (luminous) generation, without attenuation, apparently, of the microbes' action. The disease follows a regular course; and the animal dies in three or four days, the phosphorescence lingering some hours after death. M. Giard also inoculated crabs successfully, and will describe results later.—On the metamorphosis and the migration of a free Nematode (*Rhabditis oxyuris*, Cls.), by M. R. Moniez. This animal is common in cow's dung. Young individuals fix themselves to the carapace of an Acarian (sometimes as many as sixty on one), by a chitinous plate (secreted from the anterior part) and short stem; then the tissues and organs shrink together from the transparent skin, forming a smaller ovoid body. When the dung dries, the Acarian, with these new larvæ on it, attaches itself to some insect, and is conveyed to fresh dung, where new transformations doubtless take place (not followed by the author). This was observed in August.—On the probable cause of the frondal bifurcations of ferns, by Dom B. Rimelin. When one of these anomalies is met with, others may generally be found quite near. The author thinks they must be due to fungi, *e.g.* of the family of Uredineæ; basing this induction on the diseased look where they are numerous, reproduction of the anomalies from sori of those divided ferns (considered with the fact that some parasitic fungi specially affect the organs of reproduction), &c.—Recent eruptive rocks of the Western Pyrenees, by MM. Seunes and Beaugey.

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